Gas Journal

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Editorial Notes

The New Watson House

On Thursday of last week Watson House, the Research, Training, and Testing Station of the Gas Light and Coke Company, was opened in its new premises at Fulham by Lord Snell, the Chairman of the London County Council. It is just ten years since Watson House, a bold and far-sighted venture, came into being at Battersea. We suggest that no single organization in the Gas Industry of this, or, indeed, any other, country has done more to promote the prosperity of gas than has Watson House. Throughout its aim has been the satisfaction of the consumer; and this object has been achieved. It is an aim which has demanded, and continues to demand, a consistently fresh outlook, the outlook of to-morrow rather than to-day. It is an aim, too, which for its fulfilment has necessitated a truly remarkable piece of organization. There have been no half measures in the planning of this vast scheme; it is a "whole hogger." There is no question that Watson House has proved a paying proposition to the Gas Light and Coke Company, but its activities have given benefit far beyond the "confines"—if such an expression can be used—of the Company.

On later pages is an account of the opening of the new Watson House, from which will be gathered some idea of the premises, though it is impossible to describe in any detail the work which is being carried out in the various departments. A tour of the light and airy research laboratories, industrial workshops, training shops, and classrooms is a fascinating experience. The way everything is planned must give a zest to all who are working there. Not the least impressive are the industrial showrooms, which exemplify the great strides made in recent years in the design, performance, and finish of industrial gas equipment. Gas is helping towards attractive factories, as well as towards attractive homes, and research and experiment such as are being carried out at Watson House in collaboration with the manufacturers of appliances are constantly extending the field of gas in industry. The whole of the work at Watson House is so admirably co-ordinated, and only in an organization of this nature could the application of gas in all its aspects be studied to such practical purpose. There are new ideas in plenty, with highly skilled staff, provided with the fullest equipment, to put these ideas into effect. Theory and practice are happily blended, and all the investigations in progress have a common starting point and a common result—the satisfaction of the consumer. The factors of comfort, convenience, utility, economy, and safety in use of all types of gas-burning apparatus are considered separately and as a whole in these investigations. The purpose is to provide, always with the co-operation of the appliance makers, apparatus which will ever give the consumer better satisfaction. The purpose is being fulfilled through the broad outlook which characterizes the planning of these investigations.

At the opening ceremony Sir David Milne-Watson rightly claimed that the Gas Light and Coke Company and its brother gas undertakings habitually provide a service more complete, both in the extent of what it covers and the thoroughness with which it is carried out, than that offered by any comparable supply industry in this country or abroad, and it is provided with little general recognition of what it involves in the expenditure of money, brains, and effort. The new Watson House demonstrates the meaning of one phase of this service—what is termed the supply side. We hope that every opportunity will be taken of inviting people indirectly or in no way connected with the Industry to visit Watson House. They will have their eyes opened, and will still further regard the "gas man" as a friend. To the public the fitter is the "gas man," and the fitter has a great responsibility not only in respect of the standard of his work—and, after all, the best appliances can be ruined by faulty installation—but also in regard to the general manner in which he deals with consumers.

In this connection the training work at Watson House is one of the most important of its activities. The training of apprentices, though it covers only 10% of the work of the Training Section, is in some ways the most interesting. Selected boys graduate to Watson House to train as fitters. They are taught the whole job in a thorough 6-year apprenticeship, theory and practice being complementary to each other. All the boys go to a technical institute for one whole day each week, and institute fees, and in some cases fares also, are now being paid for no fewer than 2,000 students.

This is the largest example in this country of co-operation between local educational authorities and an industrial organization. An extension of the training scheme is to be made during the coming year. Alongside the actual training classes, it is proposed to establish what Sir David described as a college or a series of meetings along the lines of a summer school, at each of which a number of people drawn from every type of the Company's employees will spend a week at Watson House pooling their experience and discussing their common problems. "We want," said Sir David, "to make Watson House an intelligence centre and meeting ground for people who will represent every conceivable side of our work, from engineers to service supervisors, from salesmen to gas chemists." Such a plan, we are sure, will be greatly advantageous.

The staff at Watson House now numbers nearly 900. In 1926 the number of different appliances on which research work was carried out in the laboratories was 50. For 1936 the figure is 700. This gives an idea of the development which has taken place in this direction since Watson House was first opened. The period has been one of immense advance. In the main hall of the new premises is an exhibition, which is to remain for some time, comparing 1926 with 1936. It is a remarkable demonstration of progress. We predict, however, still more rapid and remarkable changes during the next ten years. To those in the Gas Industry, a visit to Watson House is a tonic and an inspiration. To those outside our Industry it cannot be otherwise than a revelation.

Dilution of Coal Gas

THE subject of diluting straight coal gas is one of much importance, and the method adopted must be governed in large measure by local circumstances. The practice, which is common in several small works, of reducing the calorific value of the gas made by pulling on the retorts is to be deprecated in that it is impossible to afford the consumer the supply which he requires—gas of constant quality and gravity. Also, one must consider the damage done to refractory materials by pulling, and its general effect on working results and the life of the setting. Benzole recovery provides one means—and, under present conditions, a profitable means—of dilution; and benzole recovery can be coupled with three alternatives to over-pulling. These alternatives are the addition of water gas, produced either in an external plant or by steaming, of producer gas generated within the setting or externally, or of flue gases. From the point of view of inerts, water gas, of course, holds the most favourable position, but many favour the addition of producer gas on the score of cost. Advocates of the use of producer gas from producers utilized for heating the settings put forward as advantages low capital cost of the installation, saving in labour, and very small cost of repairs and maintenance. On the other hand, advocates of external producers point out that in this way the diluent is of constant calorific value and specific gravity, and the plant can be easily controlled and is capable of meeting irregular demands.

The calorific value of the gas which should be distributed should, we suggest, closely approach the highest value which can be most economically and at the same time consistently produced, while it must be a gas eminently satisfactory in use at the burner. This question of gas quality is a matter of the utmost moment. It is not enough to produce so many therms of some type of gas; and we welcome the fact that work is to be carried out under the auspices of The Institution of Gas Engineers at Leeds University on the subject of gas quality in relation to utilization, which work links up directly with other investigations to be undertaken on gas manufacture by the Institution. As things stand at present, it does seem that to distribute, say, 20% more volume to perform satisfactorily the service required by the consumer can only be justified if the saving in cost of production outweighs the increased standing and maintenance charges which arise in consequence of the larger mains, services, and meters which, at any rate theoretically, have to be provided, and upon the increased capacity required of works subsidiary plant.

Results at Hertford

"THE Dilution of Horizontal Coal Gas" was the title of an exceedingly interesting Paper by Mr. C. A. Deas to the Southern Association of Gas Engineers and Managers, publication of which is concluded in to-day's issue of the "JOURNAL." Mr. Deas describes the method of dilution practised at the Hertford Works of the Tottenham and District Gas Company, and gives the results of a long-term investigation into this means of dilution. As long ago as 1931—"JOURNAL" for Dec. 23 of that year—he reported results of the method. Since that time the Hertford Company has been amalgamated to the Tottenham Company, and with the latter's greater resources it has been possible to investigate the matter more closely. The declared value of the gas is 500 B.Th.U. and a high rate of benzole extraction is practised—varying from 3·3 gallons in the summer months to 3·8 gallons in the winter months—yet such is the calorific value of the horizontal coal gas made, 645 B.Th.U. with 10-hour charges, that further dilution is necessary. In regard to the results of straight carbonization at Hertford, where a good coke market is enjoyed, it may be mentioned that the Hydrocarbon Enrichment Value has the high figure of 38. The Author maintains that the most economical method of working is to aim at the maximum yield of coal gas therms per foot of retort and carry out dilution afterwards under complete control.

The producer gas at Hertford is made externally in a converted water gas plant from a mixture of large coke, breeze, and slurry, the method of operation being fully described by Mr. Deas, and the gas is admitted in the desired quantities at the inlet of the exhauster. The inert content of the mixed gas is around 17%. This compares with an inert content of about 9% were water gas employed as diluent. The Author, however, contends that the composition of the gas supplied when producer gas is the diluent is more suited for satisfactory working on the district, and backs up his argument by a report of Mr. P. C. Gardiner, Chief Chemist to the Tottenham Company. The air required for combustion and the calorific value at the burner head favour the coal-gas water-gas mixture, but "it has been found over a number of years by experiments in the laboratory, confirmed by results on the district, that the coal-gas producer-gas mixture is far more satisfactory." The laboratory tests were carried out on standard lighting burners as normally supplied. It was found that varying the proportion of producer gas over a wide range does not upset such burners. With the coal-gas water-gas mixture the burners were found to be very sensitive to changes in the percentage of water gas present. The point is that a relatively small quantity of producer gas—of itself having a lower Ott number than blue water gas—is required to

reduce the coal gas to 500 B.Th.U., and that the larger content of carbon dioxide and nitrogen in the mixture after diluting with producer gas tends to lower the upper combustible limit and slow down the velocity of the flame and thus allow rather more air to be used before lighting back occurs. It will be noted from the Paper that the specific gravity of the coal-gas water-gas mixture is 0·492, while that of the coal-gas producer-gas mixture is 0·523; which must have its bearing on the carrying capacity of the mains. In regard to costs, Mr. Deas gives the cost of producing the coal-gas water-gas mixture as 2·66d. per therm, and the coal-gas producer-gas mixture as 2·54d. These figures do not take into account capital charges.

Gas Appliance Costs

It was only as we went to press last week that we received the notice, issued under date Nov. 30 by a comprehensive list of gas appliance makers, of an advance in the prices of goods supplied on and after Dec. 1. The notice appeared in our issue of last week, but there was no opportunity of referring to it editorially.

The light in which gas undertakings regard gas consuming appliances unfortunately varies considerably. But whether in the individual case they are required to show a handsome profit on re-sale to the public, or are retailed, hire-purchased, or hired on the very best possible terms purely with a view to developing gas consumption, they are an essential of the Industry's primary business of selling gas, and a condition of rising costs in this direction must be regarded with a seriousness little less than rising costs of gas manufacture when they occur. The announcement, therefore, of the manufacturers cannot be otherwise than unwelcome to the gas undertakings side of the Industry, as it must indeed be to the manufacturers themselves, since their progress must necessarily in the end be dependent upon the development of the supply side. None the less, it cannot have come as any great surprise, as the makers of gas appliances are themselves dependent upon raw materials which are common to other industries, and over the price of which they have no control, and upon a high ratio labour cost.

Just a year ago—and this was not the first warning we had given—we called attention to the rises which had already taken place in many of the raw materials involved, and even at that time it made a sufficiently formidable list, coupled with increases in wage rates already granted and others anticipated. It is common knowledge that the past year has enormously increased still further the demand for such materials with the weight of the re-armament policy added to the steady recovery, from slump levels, of normal trade and re-equipment. Equally, the demand for skilled labour in the engineering trades has almost outstripped the supply. To those, therefore, who have given any thought to the difficult conditions with which the makers have been faced, last week's announcement can, as we have said, have occasioned little surprise. The prospect of some increase must, indeed, have been so clear that doubtless many undertakings had made their plans to meet it.

The Industry, and indeed the public, looks largely to Mr. H. James Yates, as Chairman of Radiation, for light on matters of this kind in his speech at the Annual General Meeting. In February last he made quite clear the difficulties of the position, and an important point which he stressed was the continual embodiment in gas appliances of improvements and developments. Full credit has been given in public to the makers on several occasions this year by leaders of the Industry for their remarkable progress in this direction, but it must not be forgotten that not only do such developments in themselves add to cost, but they are the result of research work the cost of which is probably little dreamed of by the average man. This research, both of itself and in its practical expression in gas appliances, is of inestimable value to the Gas Industry; its continuance is something which the Industry cannot afford to refuse to support.

While, therefore, gas undertakings in the difficulties with which they are themselves faced require gas consuming appliances at the very lowest possible prices consistent with the highest quality, the manufacturers appear in this instance to have every justification for the increase for which they are asking. Taking into account the extent of the additional costs they are bearing, we believe it is a moderate one; it would have occasioned us no surprise had they asked for it long ago.

Forthcoming Engagements

Dec.

11.—I.G.E.—Gasholder Committee, 2.30 p.m.
12.—Scottish Juniors.—Joint Meeting at Glasgow. Address by R. Robertson (Junior Vice-President, I.G.E.).
12.—Yorkshire Juniors.—Meeting at Barnsley; Paper by J. A. Derbyshire.
12.—Western Juniors.—Meeting at Exeter. Paper by H. Oliver.
15.—I.G.E.—Gas Education Executive Committee, 2.30 p.m.
16.—B.C.G.A.—Executive Committee Meeting, Gas Industry House, 11.30 a.m.
17.—I.G.E.—Refractory Materials Joint Committee, 2.30 p.m.
17.—S.B.G.I.—Council Meeting at 2.30 p.m.
18.—London and Southern Juniors.—Meeting and Paper by J. Grayston.

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2.—London and Southern Juniors.—Visit to Fuel Research Station, Greenwich.
5.—I.G.E.—Research Executive Committee, 2.30 p.m.
9.—Scottish Eastern Juniors.—Visit to Alder & Mackay, Ltd., Edinburgh.
9.—Scottish Western Juniors.—Paper by W. Gledhill, of Stirling, "Development of a Gas-Works Amalgamation."
11.—I.G.E.—Finance Committee, 1.45 p.m.; Membership Committee, 2.15 p.m.; General Purposes Committee, 3 p.m.; Benevolent Fund Committee of Management, 4.30 p.m.
12.—I.G.E.—Council, 10 a.m.
13.—I.G.E.—Board of Examiners, 2.30 p.m.
14.—I.G.E.—Public Lighting Sub-Committee, 2.30 p.m.
14.—Midland Juniors.—Paper by G. E. Stevenson, of Long Eaton, "Obtaining the Goodwill of the Consumer."
15.—I.G.E.—Joint Committee on Complete Gasification under Pressure (16, Old Queen Street, S.W. 1), 3 p.m.
16.—Yorkshire Juniors.—Meeting at Sheffield. Paper by A. E. Wilson, "My Last Twelve Months with Industrial Gas."
19.—I.G.E.—Gas Education Executive Committee, 11 a.m.; Gas Education Committee, 2.30 p.m.
22.—London and Southern Juniors.—Paper by T. J. Legge and T. G. Noble, "Baffler Performance in Relation to the Safety of Gas Appliances."
23.—Midland Juniors.—Visit to Walsall Gas-Works.
23.—Scottish Western Juniors.—Visit to Port Glasgow Gas-Works.
23.—Western Juniors.—Visit to Works of Swindon United Gas Company. Paper by D. A. Vince, of Swindon.
23.—Wales and Mon. Juniors.—Meeting at Neath. Paper by D. Rees, of Neath, "Reconstruction of an 1877 Gasholder."
29.—I.G.E.—Liquor Effluents and Ammonia Committee, 11.15 a.m.; Joint Research Committee, 2.30 p.m.

Personal

Retirement of G. F. Twigg.

Castleford and a number of local organizations with which they have been connected will be the poorer by the impending departure of Mr. and Mrs. G. F. Twigg. Mr. Twigg, who has been the Engineer and Manager of the Castleford and Whitwood Gaslight and Coke Company for the past nineteen years, has now severed his association with the Company, and in retirement will take up residence at Exmouth, Devon.

Mr. Twigg was one of the founder members of the Castleford Rotary Club in 1924, and two years ago was elected President. At the Gas-Works on Wednesday afternoon, Nov. 25, the former Directors of the Company made a presentation to Mr. Twigg. Mr. W. T. Cliffe, J.P., presided, the presentation being made by the senior Director, Mr. R. M. McDowall, who spoke of the valuable work Mr. Twigg had done for the Company for nearly 20 years. Mr. Twigg suitably replied. Later, Mr. Twigg was the recipient of a barometer from the members of the Rotary Club. The staff and employees of the Castleford and Whitwood Gaslight and Coke Company assembled in one of the fitting sheds at the Gas-Works on Friday, Nov. 27, to make presentations to Mr. and Mrs. Twigg. Mr. F. Liversidge presided, and was accompanied by Mr. H. L. Wilson (Secretary and Director) and Mr. T. Underwood (the oldest employee of the Company). Mrs. Twigg was unable to be present. Mr. Liversidge said that Mr. Twigg had always been ready to help them in any of their activities, either social or otherwise. Anything put forward for their benefit had always received his kindest consideration, and he had assisted in any charitable object for the good of the town. Mrs. Twigg, too, had always been ready to help, and they regretted that she was not able to be present owing to a previous engagement. Expressions of appreciation of Mr. Twigg and of regret at his leaving were voiced by Mr. Underwood, Mr. J. T. Parnaby, Mr. T. Armitage, and Mr. C. Mountain.

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Councillor A. E. HEWITT has been reappointed Chairman of the Stoke-on-Trent City Gas Committee.

Obituary

Sympathy will be extended to Mr. THOMAS H. NIELD, formerly Engineer and Manager of the Hebden Bridge and Mytholmroyd Gas Board, on the death of his wife on Dec. 2, at "Glenelg," 27, Duchess Drive, Blackpool.

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The death is announced this week of Mr. WILLIAM BARRY HARRINGTON, Chairman of the Cork Gas Consumers' Company. He took an active interest in numerous Cork firms and was much esteemed for his keen business ability.

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Alderman ROBERT BERESFORD, three times Mayor and five times Deputy Mayor of Newcastle-under-Lyme, and Chairman of the Borough Gas Committee, passed away in a London nursing home on Saturday, Nov. 28, after a brief illness. For many years he was Vice-Chairman of the Gas Committee, taking over the Chairmanship in 1931.

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We regret to announce the death at the age of 74 of Mr. WILLIAM EDGAR, who passed away quietly at his home on Dec. 6.

Mr. Edgar was the Founder and Governing Director of Wm. Edgar & Son, Ltd., and a Founder Member of the Society of British Gas Industries. He was perhaps best known to the Industry as the inventor of the "Blenheim" gas fire. He leaves two daughters and a son.

News in Brief

Applications for the Position of Chemist are invited by the Dundee Gas Department. Further particulars are to be found in our advertisement columns.

An Assistant to the Sales Manager is required by a large South Coast Gas Undertaking. Full particulars will be found in the advertisement columns of this week's issue.

An Extension of Area of Supply is one of the objects of a Special Order for which the Teignmouth Town Council intend applying to the Board of Trade under the Gas Undertakings Acts, 1920 to 1934.

Notice of a change of calorific value is given by the Witney Gas and Coke Company as and from March 2, 1937. After that date the gas supplied by the Company will be 460 B.Th.U. per cu.ft. instead of the present value of 450 B.Th.U. per cu.ft.

New Coal-Handling Plant is to be installed at Belfast Gas-Works. The old plant has been in service since 1876 when the Department's coal consumption was 50,000 tons as compared with the present figure of 192,000 tons per annum. The total cost of the replacement scheme is estimated at £33,000.

A Co-Operative Effort by the Undertakings at Guisborough, Middlesbrough, Redcar, South Bank, and Stockton resulted in a full-page of good publicity for gas appearing in the *Northern Echo* for Nov. 28. The advertising matter was arranged around an excellent article on kitchen planning and gas cooking by Mrs. Guy Martin.

In Connection with Our Reference to the Cake Baking Competition organized by the South Suburban Gas Company recently at Petts Wood, it was mentioned in last week's "JOURNAL" that there were no gas showrooms in this area. We are pleased to learn from the Company, however, that they have had showroom premises in this district for some little time past now.

Application for a Special Order under the Gas Undertakings Acts, 1920 to 1934, is intended to be made to the Board of Trade by the Winsford Gas Company (whose registered office is at 15, Moorgate, E.C. 2) with the object *inter alia* of purchasing the gas undertaking of the Winsford Council. It will be recalled that earlier this year the Severn Valley Gas Corporation acquired the Winsford Undertaking. The Winsford Gas-Works were originally purchased by the Council in 1904 from the Wharton and Over Gas Company.

Splendid Work was accomplished in the interests of gas at the recently concluded exhibition and cookery demonstrations at Luddendenfoot, Yorkshire. Congratulations are due to Mr. W. B. Harrison, Engineer and Manager, Sowerby Gas Department, for the excellent arrangements made. In spite of the foggy weather, splendid attendances were recorded, and the sales of gas appliances were exceptionally good. The lectures were ably conducted by Miss Eccles, C.D.S., who demonstrated with modern cookers with oven heat controller by Cannon Iron Foundries, Ltd., and Messrs. Fletcher Russell & Co., Ltd. (Radiation Ltd.).

A Supply of Gas is wanted at Southam, and at a recent Parish Council Meeting it was asked if there was any likelihood of gas coming to Southam. It was felt that there should be competition. The Clerk referred to a letter last July from the Leamington Priors Gas Company in which the Directors stated that the question of extending their gas mains to Southam was under consideration, but Southam was at present beyond the limits of their area of supply. They would get into communication with the Board of Trade with the view to getting their area extended, and communicate with the Council again when matters were a little further advanced.

Gas Journal Shewring Fund

Donations are invited to the Fund, full particulars of which were given in the "JOURNAL" for July 22. The Management of the Fund is in the hands of Messrs. F. G. Shaw (Buxton), W. W. Townsend (Colchester), and J. Bridge (Elland). All expenses having been guaranteed, the whole of the sums received will be applied, without any deduction whatsoever, to the benefit of the widow and children of Harold Shewring, by whose tragic death earlier this year they were left in distressed circumstances.

Cheques should be made payable to the "GAS JOURNAL," and crossed "Shewring Fund Account." All donations will be gratefully acknowledged by the Editor, who is Treasurer to the Fund.

We are pleased to be able to announce that the total to date amounts to £897 10s. 10d.

For **Central Heating Purposes** the Llandudno Urban Council has decided to make a reduction in the charge for gas to 3s. per 1,000 cu.ft. in order to encourage consumers to make extended use of the supply. It is hoped by the concession to induce the bigger consumers to increase their consumption during the winter months, when the load at this seaside resort is not so heavy as in the summer.

The **Scale of Charges** to industrial consumers is to be adjusted by the Rotherham Corporation Gas Department, who have deemed this advisable so that all the industrial consumers come on to the same common basis of charge. Previously, various rates were in force. The adjustment increases the price of gas slightly, and has been necessary in view of the heavy capital expenditure incurred to meet the ever-increasing demand for gas.

Consumption of Gas within the area supply of the Stockton Gas Department is steadily increasing. During the twelve months ended March 31, 1936, over 705 million cu.ft. were produced, an increase of 16,088,700 cu.ft., or 2·33% more than the previous year. The increase during the six months ended Sept. 30 is 14 million or 4·59%, compared with last year, while for the present month to date the increased output is 5·4 million cu.ft. or 10·29% more than for the same period last year. The main reason for this healthy state of affairs is the increasing use of gas cookers—no fewer than 326 were supplied during September and 196 during October. Another source of increased consumption is due to business premises converting their heating apparatus from solid to gaseous fuel. The graduated scale of charges, based on the rate of quarterly consumption, makes gas an attractive proposition for such purposes.

Amalgamation and Grouping

Sudbury and Long Melford.

The acquisition of the Long Melford Gas and Coal Company, Ltd., is one of the objects of a Special Order for which the Sudbury Gas and Coke Company, Ltd., intend applying to the Board of Trade under the Gas Undertakings Acts, 1920 to 1934. Other purposes of the Order seek to authorize the Company to supply in added limits and to empower the Directors to reserve a proportion of any issue of shares for exclusive offer to employees of the Company and to their consumers and to make provisions as to the conditions of issue. The Company also seek to acquire certain lands for gas-works purposes.

Gas and Sheffield's Prosperity

Address by Mr. Ralph Halkett

On Nov. 27 Mr. Ralph Halkett gave an Address to the Sheffield Publicity Club on how gas helps forward Sheffield prosperity. He mentioned that since 1931 the amount of town gas used in the Sheffield metal industries has increased by more than 3,000 million cu.ft.—an increase alone equivalent to the displacement of something like 200,000 tons of coal per annum, and, reckoned in heat units, to more than the total output of electricity by the Sheffield Corporation for all domestic and commercial use.

This tremendous increase, he said, indicates the considered judgment of many firms—judgment based on true commercial values and an appreciation of the fact that progress in modern competitive markets demands modern precision methods in the use of fuel.

"Thousand Cakes" Competition

Excellent Response

Judging will be no easy task in the "Thousand Cakes" Competition organized by the South Metropolitan Gas Company in conjunction with Messrs. Holdrons, of Peckham, for entries in excess of this number are confidently expected. Reference to this Competition was made in these columns on Nov. 11 last, while a photograph of the window display at Holdrons, which was exclusively devoted to showing the prizes, was published the following week. It may be mentioned that a hundred prizes are being offered by the Company and Messrs. Holdrons, the first being valued at £12.

The cakes entered for the Competition will be on view at Messrs. Holdrons from Thursday of this week, and the distribution of prizes will be made on the following day by Miss Zena Dare. After the preliminary judging of the entries, the final places will be allotted by Mr. J. K. Gawith, of J. Lyons & Co.

North of England Gas Managers' Association (Auxiliary Section)

Half-Yearly Meeting at Newcastle

The Thirty-Third Half-Yearly Meeting of the Auxiliary Section of the North of England Gas Managers' Association was held in the Gas Offices, Newcastle, on Saturday, Nov. 28.

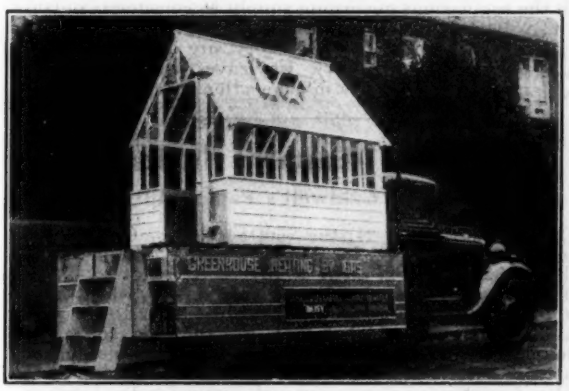
The CHAIRMAN (Mr. J. R. Porter, of South Shields) presided and referred to the death of Mr. Dugald Currie, former Engineer and General Manager of South Shields Gas Company; as a mark of respect, the members stood in silence.

The following officers were elected:

Chairman.—J. W. Pallister (Middlesbrough).
Vice-Chairman.—G. Neil (Southampton).
Member of Committee.—J. Cleator (South Bank).
Hon. Secretary.—L. M. Weldon (West Hartlepool).

Mr. J. F. Lord then presented a Paper entitled "Preparing for Coke Oven Gas."

A Greenhouse Heating Display



This ingenious greenhouse heating display has been arranged by the Watford and St. Albans Gas Company and is at the present time touring their district with excellent results. As the Company point out in an appropriate leaflet on the subject, they obviously could not erect a greenhouse, complete with heater, in their showrooms and invite all their gardening friends along—but they have done the next best thing: they have put the whole display on a lorry and are taking it to them. The heater consists of a Richmonds "Daisy" greenhouse heater, and the display stops in certain roads at definite times, and consumers living in the vicinity are notified a day or two before by means of the leaflet already referred to. This is sent to them together with a booklet describing the heater. Consumers can mount the lorry by means of the steps at the rear and can inspect the installation, a realistic touch being added by a display of plants, ferns, &c., in the greenhouse. A special representative travels with the lorry.

Gloucester's Ten-Year Lighting Contract

Main Roads Involved

An up-to-date system of lighting is shortly to be installed on certain main roads in the suburban area of Gloucester. A contract for a period of ten years has been made with the Gloucester Gas Light Company for a reconstruction of the existing lighting.

The contract provides for lighting of a type, generally speaking, to give sufficient illumination to enable motorists to drive with safety up to 30 m.p.h. without headlights. Among other improvements, the lamp standards are to be extended so as to carry the lamps 15 ft. above the road level; standards will be at intervals of not more than 50 yds., and will be in staggered formation. Four-burner gas lamps with directional reflectors of the latest type will be used, the candle power of the existing lamps being trebled. In all 164 lamps are involved by the new agreement.

This number may be considerably increased in the near future, since the Hucclecote Parish Council at a recent meeting approved the extension of the area of lighting to the outer part of the Parish.

S.B.G.I. Golfing Circle

Autumn Meeting at Wimbledon

The Autumn Meeting of the S.B.G.I. Golfing Circle was recently held on the course of the Wimbledon Park Golf Club by the kind permission of the Committee.

The competition for the Yates Bowl in the morning was won by Mr. C. H. Kempton, and the Foursomes Competition in the afternoon for prizes presented by the Captain, Mr. J. H. Kemp, was won by Messrs. C. R. Averill and M. H. Thornton.

The Annual General Meeting of the Circle was held during the day when the accounts for the year were approved, and Mr. R. P. Chester was elected Captain for the ensuing year.

Gas to Help Famous Firm

Messrs. Wedgwood Take Special Supply

In reply to representations from the famous firm of Messrs. Wedgwood & Son, who propose to build a modern factory at Barlaston, a country district just outside the borders of Stoke-on-Trent, the Stoke-on-Trent City Gas Committee has decided to offer to give the necessary supply at the usual charges according to scale, *plus* 4d. per 1,000 cu.ft. to cover boosting charges and to conform with the regulations governing supply to consumers outside the City boundary, the consumers to bear all costs necessary to give a supply to the factory site and to make all arrangements for necessary wayleaves through private lands and pay all expenses in connection therewith.

Scottish (Eastern) Juniors

Visit to Caldwell's Paper Mill

On Saturday, Nov. 21, the Scottish Junior Gas Association (Eastern District) inspected Messrs. Caldwell's Paper Mill Company, Ltd.'s, plant at Inverkeithing.

The grass, after passing through the duster, which teases out the small sheaves and extracts dust, goes to the grass boilers where it is boiled with caustic soda to remove colouring matter, rosins, silicates, and other non-fibrous matter. After being boiled the grass is blown out of the boilers by means of a water jet and pumped to the breakers. Here it is bleached with hypochlorite of lime, the residue being a white fibre. It is then passed through the straining plant to remove any roots, &c., that may still be present.

The fibres in suspension in water are known from now up till the paper machine as "stuff." In the beaters the stuff is treated so as to produce a sheet of paper having the particular character and quality desired. Within the compass of beater treatment one can produce papers varying from blotting and book paper to the thin crackly banks and bonds. From the beaters the stuff is dropped along with a large quantity of water to the "stuff chests" where the necessary dyes, &c., are added. In order to make the paper resistant to ink, rosin size and alum are added in the chests. The mixing of these two materials forms a coating on the fibres which prevents ink from "running" as on blotting paper. For this latter paper, of course, no rosin size or alum is used.

From the chests the stuff runs to the paper machines where the sheet is actually formed. The largest machine in this mill makes a sheet 156 in. wide. The "stuff" or fibre floating on water is pumped from the chests and flows through a rotary strainer where the remainder of foreign matter is caught in the fine slots before the pulp goes on to the machine wire, which is an endless wire gauze made of phosphor bronze. The wire is continuously moving forward on the series of rollers known as tube rolls, and the water is drained through from the forming sheet by the capillary action of the tube rolls. As the rapidly forming sheet is carried towards the end of the wire frame more water is drained off and this is much accelerated by the use of suction boxes and a suction roll, which remove the water by mechanical action. It is at the suction boxes, where the wet sheet is fairly well formed, that the watermark is applied by means of the dandy roll. At this point there is the remarkable sight of a sheet of liquid being transformed into a sheet of paper. After the sheet is taken off the suction roll it is carried by means of felts in between rollers, known as press rolls, which serve to press out some water, and from here, is carried over the drying cylinders which are hollow and heated by steam. After leaving the drying cylinders the sheet of paper may be taken through the machine calenders in order to impart a finish to the surface. The machine calenders are hollow chilled steel rolls, heated by steam, and act in a similar way to the household iron. The sheet is next rolled up at the end of the machine, and may then be cut into sheets or slit into reels according to customers' requirements. The final operation is the cutting of the paper into sheets of the desired sizes, each lot then being sent on to the finishing house where the paper is overhauled and counted. All faulty sheets, containing dirt or specks, and those not of the correct shade are rejected here.

Stonehaven Celebrates Centenary

Exhibition and Demonstrations

An exhibition of modern gas appliances in the Town Hall, Stonehaven, was opened by Mr. John Wilson, Engineer and Manager of Dundee Gas Department, on Dec. 1.

The exhibition was organized by the Stonehaven Gas Company to celebrate the centenary year of the Company. Everything that gas can do for the community is demonstrated at this exhibition, which will remain open until Dec. 12. The lay-out is a credit to the Engineer and Manager, Mr. John Scobie, and his staff. Provost Thomson presided at the opening ceremony in the unavoidable absence of Mr. James Hall, Chairman of the Directors.

At the subsequent luncheon Mr. Wilson proposed the toast of "The Stonehaven Gas Company." Provost Thomson, in reply, said that the Company's output of gas had increased from 10,840,000 cu.ft. in 1900 to 39,252,000 cu.ft. at the present time. Recalling that Mr. Scobie was appointed Engineer and Manager in 1931, the Provost said that in 1930 the output was 30,370,000 cu.ft., and the coal used 2,375 tons. While this year the output had risen to practically 40 million cu.ft., 300 fewer tons of coal had been required for its manufacture. These figures pointed plainly to the fact that in Mr. Scobie they had a very efficient, energetic, and reliable man.

"Our guests" was proposed in a witty speech by Dean of Guild Burns, and the reply was by ex-Provost Howie, who thanked the Stonehaven Gas Company for their hospitality and paid special tribute to Mr. Scobie for services which he had given to the Laurencekirk Gas Lighting Society recently in connection with improvements to their plant.

The Company drank the Chairman's health, on the call of Bailie George.

A feature of the exhibition were the cookery demonstrations given by Miss M. K. Gompertz.

Southport Gas Estate

Committee's Inspection of Works

Members of the Southport Gas Committee and of other committees visited the Southport Gas-Works at Crowlands on Wednesday, Nov. 25. They were shown round the Works by Mr. J. Herbert Clegg, Engineer and Manager, and Mr. W. E. Plevin, Deputy Engineer.

The Chairman, Councillor W. Lea, said that the Gas Department had had an increase in gas consumed over the last two or three years and a substantial increase of profits, which amounted to £17,400 in 1934-5 and £21,000 for the year 1935-6. As a result of this profit the Committee had decided to introduce a tariff which would enable them to compete with coal, oil, and electricity. The launching of this tariff would take from the annual profit a sum of £7,000, but an anticipated increase in consumption would earn them further revenue and would, he hoped, enable them still further to reduce the price of gas.

Councillor Houldsworth, Vice-Chairman, welcomed Mr. Plevin, the new Deputy Engineer.

Mr. Clegg said in the past year they had a very busy time endeavouring to make some improvements and repairs of maintenance. A year ago he painted a gloomy picture and he was sorry he would still have to do so this year. Consumption in the past two weeks had increased due to the exceptionally cold weather coming earlier than anticipated. This increased consumption of gas brought to light defects in the distribution system. They had hundreds of complaints about rust in the pipes. They were rushing through a new 14-in. main to supply Marshside and Banks, by Christmas, otherwise he dare not think what the consequences might be, and when they made the joint with the old main they observed that this, too, was half-full of rust. Apparently they were going to have to take up half the streets in Southport and many of the mains would have to be replaced by larger ones. He would submit a scheme in a few months' time for very extensive alterations. On the other hand, said Mr. Clegg, there were cheerful points. Mr. Plevin had come to them in place of Mr. H. Jack (now at Ilkley) and had put his shoulder to the wheel and made very good progress.

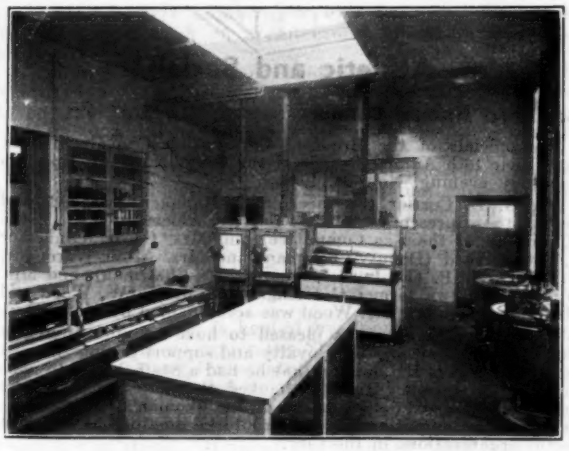
The Chairman, in replying to the thanks of the guests, paid a warm tribute to the ability of Mr. Clegg, Mr. Plevin, and Mr. G. Illingworth, Chemist,

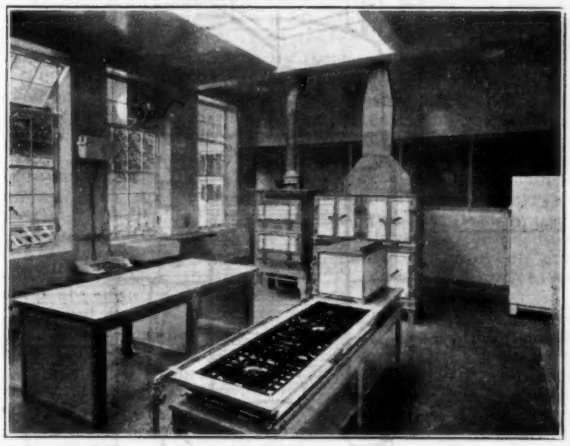
"A HEALTHY BODY AND A MIND AT EASE"

Gas Equipment at the University Hostel, Sheffield

Left.—A Typical Student's Bedroom with Panel Gas Fire.

Health and the ability to assimilate knowledge go hand in hand, and when "Oakholme," Charterhouse Road, Sheffield, was built on the site of an old Sheffield residence as a Men's Hostel for the Sheffield University it was decided that the heating and cooking facilities should leave nothing to be desired from a health point of view. The work of installing the equipment was carried out by the Sheffield Gas Company. The old house "Oakholme" has been renovated and modernized and is now occupied by the Warden. The new building comprises approximately 110 students' bedrooms, and there is also a number of other rooms for the housing and use of the staff, lecture rooms, dining hall, kitchen, servery, sculleries, &c. Each student's bedroom is fitted with a panel type gas fire. The whole of the cooking is carried out on up-to-date gas equipment, which includes: Two 20-gallon vegetable boilers, one 10-gallon milk and porridge boiler, one 2-pan fish and chip fryer, two pressure steamers for vegetables and puddings, one large hotplate with salamander at end, one battery of four roasting ovens, and one 2-tier pastry, cake, and bread oven.





These appliances are fitted in the kitchen with ventilating pipes, carried into the open air through roof. In the adjoining servery is fitted: A hotcloset and carving table with a stillroom set and double tier toaster at one end. The general scheme of colour finish to all the cooking appliances is: Framework, where exposed, vitreous mottled enamel; panels, vitreous white enamel; and bright surfaces, taps, fittings, and exposed pipes, stainless steel or chromium plate. Gas is also in use for cooking and heating in the Warden's quarters at the old residence.

Meeting the Provisions of the Shops Act, 1934

Lecture to Sanitary Inspectors

On Nov. 17, the Rochdale, Bury, and Bolton Sanitary Inspectors were addressed by Mr. T. Smith, Sales Manager of the Rochdale Gas Department, on "Meeting the Provisions of the Shops Act, 1934." The Chair was taken by Mr. H. Howarth, of Bolton, the meeting being held in the Rochdale showrooms, where a special display of apparatus for use in shops was arranged. In the course of his remarks, Mr. Smith, having enumerated the provisions of the Act, observed that all those provisions could be met with the aid of gas. Heating, ventilating, and lighting were three processes which were closely allied and had a common basis in that fuel was required to bring about satisfactory operation. A short study of the inconsistency in temperature variation in this country was sufficient to prove that our climate could not be described as seasonable in the very definite sense; therefore, it was not possible for employers to say, for instance, that heating should begin round about a certain date and continue until a certain subsequent date.

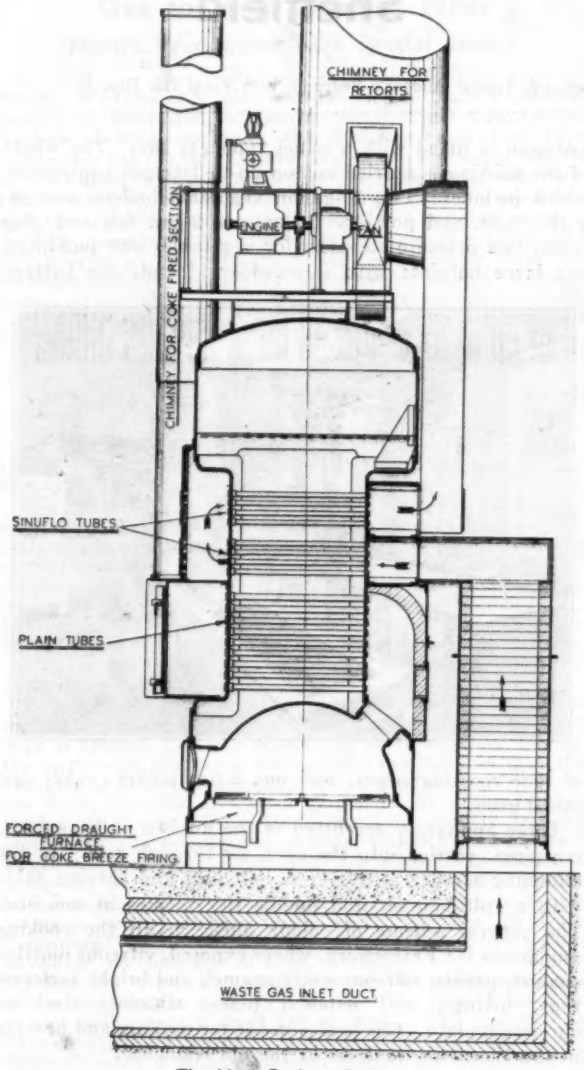
He then went on to detail the various gas heating appliances that are available, and after dealing with ventilation, pointed to the advantages accruing from the use of gas lighting.

A New "Cochran" Boiler

Waste Heat and/or Breeze Firing

Pioneers in many spheres of boiler practice, Messrs. Cochran & Co., Annan, Ltd., 34, Victoria Street, London, S.W. 1, are now producing a new boiler designed for operation, simultaneously or alternatively, on waste heat and breeze. This boiler is an ingenious combination of the waste-heat and solid fuel fired fire-tube boiler, and the makers confidently anticipate that it will fulfil a useful purpose for the smaller gas-works with outputs ranging from about 40 million cu.ft. up to about 150 million cu.ft. per annum. While fundamentally standard, the technical details of the boiler would be specially designed to give the best results for each particular works.

It is sometimes found that the amount of steam raised



The New Cochran Boiler.

by the waste-heat boiler attached to the carbonizing plant is inadequate for the demands of the whole works. Or again during times of reduced throughputs the amount of waste heat available is insufficient to operate the boiler at the required rate of steam production. Hence there is created the need for supplementary steam raising plant.

The principle upon which this new boiler operates will be clear from the accompanying diagram. It will be observed that there are two separate and distinct flue systems. The lower system is for breeze firing of the boiler and the upper for waste-heat firing. Both these systems heat the same mass of water, but embody different features owing to the peculiarities of these two modes of firing. The two systems may be operated concurrently or alternatively. The breeze firing can be brought into use at very short notice to supplement the waste heat as and when the demand for steam exceeds the output of the boiler when on waste-heat firing alone.

One of these boilers has already been installed at a gas-works in this country, but no working results are as yet obtainable. The following figures, however, we feel sure will be of interest to our readers. The diameter of the boiler is 6 ft. 6 in. and the height 17 ft. The working pressure is 100 lb. per sq.in. The waste-heat section consists of two nests of "Sinuflo" tubes which produce a maximum of 740 lb. of steam from 212° F. per hour with induced draught as in standard waste-heat boiler practice. The lower section alone with breeze firing is capable of producing 2,400 lb. of steam from 212° F. per hour. The total steam raised per hour from 212° F., therefore, will be seen to be 3,140 lb. The breeze is burnt on a forced draught steam jet grate. The induced draught fan for the waste-heat section is operated by a steam engine.

The path of the waste gases through the double pass of "Sinuflo" tubes is clearly shown by the arrows in the above diagram. As is well known, the "Sinuflo" tube is waved. Due to this special formation, a greatly increased rate of heat transmission is obtained which has been found in actual practice to be of the order of 150%. This result has been achieved by consideration of the fact that in a straight boiler tube the flow of gas molecules is roughly parallel with the tube sides. This means that many in the middle do not make contact with the tube walls at all. By forming the tube with a series of waves the gas molecules are brought into contact with the tube walls every time the curve is reversed, this ensuring that they give up their heat readily to the water. In its practical application to boiler design this means that the same transmission efficiency can be obtained with a "Sinuflo" tube of the same bore, but only half the length of an ordinary straight tube.

The tubes are made only slightly sinuous so that cleaning with a spherical brush presents no difficulties. Furthermore, they lie in a horizontal plane in the tube nest so that no troughs are formed in which dust or moisture can collect.

This boiler is an adaptation for gas-works practice of the well-known Cochran composite boiler which has been standard marine practice for a number of years. The marine composite boiler being used in conjunction with the Diesel engines utilizes the waste heat of the exhaust gases. When the engines are not running, then oil firing is resorted to in the alternative flue system. Here again the two systems of firing can be used alternatively or simultaneously.

Athletic and Social

Bradford Annual Dinner.

The officials of the Bradford Corporation Gas Department held their 16th Annual Dinner at the Great Northern Hotel on Saturday evening, Nov. 28, 1936.

Mr. G. E. Currier, Engineer and Manager, presided, and among those present were Mrs. Currier, Alderman F. J. Cowie (Chairman of the Gas Committee) and Mrs. Cowie, Councillor J. Alton Ward (Deputy-Chairman) and Mrs. Alton Ward, Mr. G. Walker, J.P. (Ex-Lord Mayor and Ex-Chairman), and Mrs. Walker, and two former Gas Engineers, Mr. C. W. Wood and Mr. E. J. Sutcliffe. Mr. Wood was accompanied by Mrs. Wood.

Mr. Currier said he was pleased to have an opportunity of thanking the Staff for their loyalty and support during the past year. He was of the opinion that he had a Staff second to none in the Corporation. He also thanked the ladies for the solid help they had given in support of the Women's Gas Council; he felt sure that ultimately this would become one of the most useful organizations in the City.

Alderman Cowie said he was pleased to be present and he would like to add his appreciation of the support the staff had given to Mr. Currier, especially so during the past few months with regard to the reconstruction scheme. He said he knew of no one more capable of controlling the work than Mr. Currier.

Councillor Alton Ward stated that the Gas Department owed its success to the team spirit, they had an excellent Chairman who took great interest in the Department, and a first-class Manager and Staff, and any business or Corporation was certain of excellent results if this spirit was maintained.

Mr. G. Walker said he was delighted to have an invitation to be present and he hoped to have many more opportunities of renewing friendships.

Mr. Wood remarked that it was nearly ten years since his retirement and he considered that he had the best Staff and it was very gratifying to know that the same spirit existed to-day.

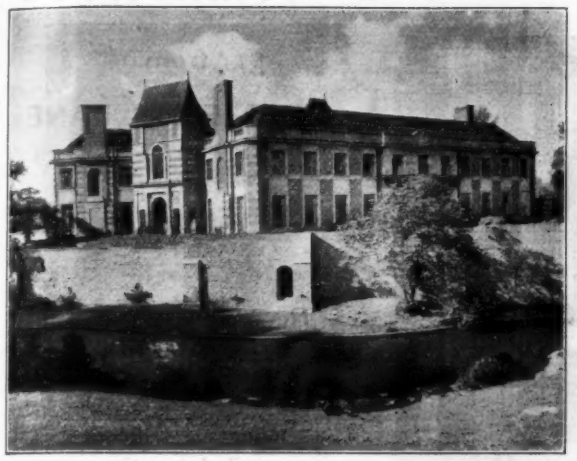
Mr. Sutcliffe said he was pleased to be present and hoped he would be present on many future occasions.

A whist drive and dance followed. A speciality dance given by Miss Hinton (daughter of a member of the staff) was greatly appreciated. The prizes for whist were presented by Mrs. F. J. Cowie.

Gas Panel Heating System for Eltham Hall

And Gas Heated Hot Water Supply

The South Metropolitan Gas Company have recently completed a most interesting heating and hot water supply system for Eltham Hall, the private residence which Mr. Stephen Courtauld has built adjacent to the famous 15th century Banqueting Hall of Eltham Palace.



Eltham Hall.

After considering every form of radiator, it was decided that the only form of heating apparatus which would provide abundant easily-controlled heat without conflicting with the decorations was the panel system.

Generally in the house the heating is by means of the panel system, which consists of pipe coils secured to the ceilings and plastered over. Hot water is circulated through the coils, with the result that the whole of the area of the ceiling under the panel becomes warmed to about 100° F. The room and its occupants are thus warmed by low-temperature radiation without the high air temperature associated with radiator systems. This means of heating is very comfortable and it is completely invisible, which, from an architectural point of view, is a great advantage.

A pump circulates the hot water to the panels through a flow main in the roof space. Separate connections are taken from this main to each panel, and the return from each panel is taken separately down to the return main under the ground floor.

Each panel is fitted with two valves, one valve in the roof space on the flow connection and one valve on the return from the panel, which is generally located behind the skirting so that it is accessible for controlling the panel.

Floor Heating

The Entrance Hall is heated by floor panels which are buried in the screed under the Stonart flooring. In order to obtain the lower temperature necessary for floor heating, these panels are fed by the return water from ceiling panels above the Hall.

There is also floor heating in the bathrooms, the floors of which are of stone. Without floor heating these would be very cold to the feet, but with it they are pleasantly warm and comfortable for walking on.

The Great Hall is entirely floor heated, the whole of the floor being used as heating surface as there are panels under its entire area. Mains are run to the Great Hall from the boiler house carrying low-temperature water. This is obtained by means of a hand controlled mixing valve which re-circulates the return water from the Hall or admits high-temperature water from the boiler in any required proportions.

The hot water supply consists of a gas boiler with an indirect cylinder in the boiler house. The primary circulation is by gravity. There is a pumped secondary circulation to within a few feet of all draw-off points, to all towel rails and linen coils. On the secondary circulation in the roof space are two high-level auxiliary storage tanks to ensure a good supply of hot water to the further bathrooms. The installation provides a completely adequate supply of hot water at such a temperature that a little cold water is necessary for a bath, and as the water is never heated to a high temperature, the throwing down of deposit in the cylinder is considerably reduced.

Potterton Boilers Chosen

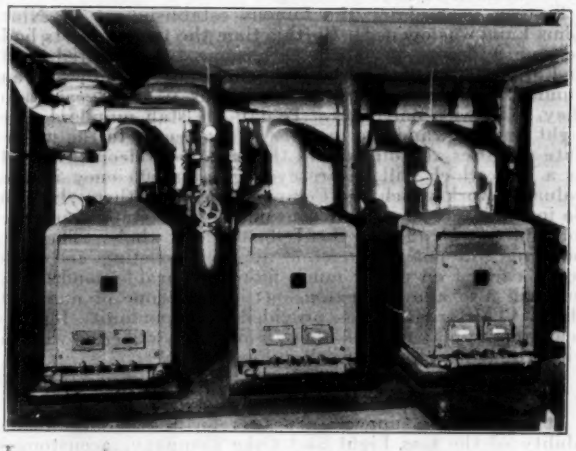
All forms of fuel for the boilers were considered and gas was chosen on account of its cleanliness, reliability, silence, and ease of operation. No stoking is necessary, and the boilers can be attended to by the household staff.

The heating is carried out by three Potterton "Rex" boilers. Twin boilers are used for the central heating, these being No. 2 Series "Rex" heaters of six sections each with a combined output of 720,000 B.Th.U. per hour.

The boilers have separate control of the gas by water-temperature thermostats of the bi-metal type, and can be adjusted to any temperature required for the varying weather conditions, but as the "Panel" system is used, this has never to exceed 120° F., at which low-temperature a very high thermal-efficiency is obtained and no condensation occurs in the flueways, whereby maintenance costs are reduced to a minimum.

For hot water supply a boiler of the same Series is used, but of four sections with an output of 288,000 B.Th.U. per hour. The gas to this unit is also controlled by a bi-metal thermostat, but operates at a high temperature and heats the storage through the indirect cylinder by gravity circulation.

The three boilers form a convenient battery in neat and compact form, being finished in grey mottled enamel with chromium-plated mountings for the sake of cleanliness. There is complete absence of smoke, dust, grit, and noise so often associated with boiler houses.



The Three Potterton "Rex" Gas Boilers.

A small independent "Equator" water heater is installed near the squash racquets court to supply the baths, basins, and showers, as the court is too far from the boiler house to be economically supplied therefrom.

The Architects were the Hon. John Seely, F.R.I.B.A., and Paul Paget, A.I.A.A., and the Engineers who carried out the installation were Messrs. G. N. Haden & Sons, Ltd.

GAS LIGHT AND COKE COMPANY'S

Activities at WATSON HOUSE Transferred

from

NINE ELMS LANE

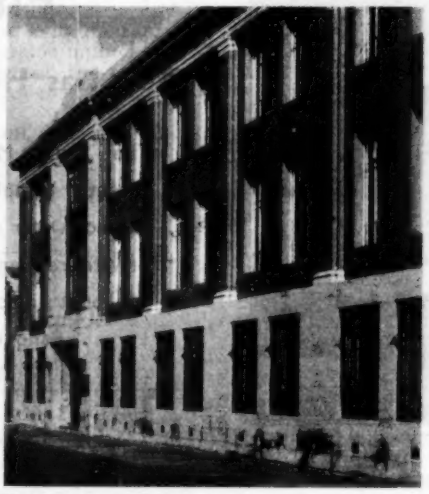
to

FULHAM

New Premises Opened by Lord Snell

Inaugural Luncheon and Inspection, Dec. 3, 1936

The transfer of the activities of the Gas Light and Coke Company's research and training sections from Nine Elms to Fulham was marked by an official opening of the new Watson House on Dec. 3 by Lord Snell (Chairman of the L.C.C.), when a representative gathering inspected the centre and was subsequently entertained at luncheon by the Company.



The Main Entrance.

The name of Watson House has for many years past been synonymous with the most up-to-date principles of research and training in the Gas Industry, and there are few in the Industry who are not familiar with much of the invaluable work which has been carried on there by the Gas Light and Coke Company since its establishment at Nine Elms Lane, Battersea, ten years ago.

It will, nevertheless, have been appreciated by those who have had the privilege of inspecting the original premises in recent times—as it was realized by the Company themselves—that the enormous growth in the research and training activities carried out there had rendered this somewhat grim building on the riverside incapable of serving adequately the present-day needs of the vast organization housed there.

To give an idea of the development of this side of the Company's work, it may be mentioned that it was in the year 1910 that the Undertaking (already in existence for almost a century) detailed two chemists in one small room to devote themselves exclusively to the special problems affecting the use of gas in the home and in industry. This far-sighted gesture marked the beginning of Watson House as we know it to-day.

Sixteen years later the famous establishment at Nine Elms Lane was opened. By this time the two chemists had become a dozen specialists with some two hundred staff and apprentices, and to-day Watson House examines seven hundred appliances in a year, whereas sixteen years ago they dealt with only fifty. To-day the staff numbers over eight hundred, and the transfer of the centre to the up-to-date premises at Fulham will therefore be welcomed by all as a step which will ensure even greater efficiency in the valuable work which the Company have set themselves to do in the interests of their consumers, their staff, appliance manufacturers, and the Gas Industry as a whole. The new building will not only enable all their existing activities to be carried on under much more favourable conditions, but will also allow of extensions in the scope of many of them. This transfer has provided an opportunity for the scientific re-planning of the various departments with a view to facilitating the work in hand.

We View the Premises.

It is, perhaps, unnecessary to refer to the organizing ability of the Gas Light and Coke Company, accustomed as they are to shepherding parties, both large and small, round their many departments; but we must at the outset pay tribute to the excellence of the organization which enabled the Company to handle so efficiently and expeditiously a gathering of the magnitude of that last week, and at the same time give everyone of us a clear insight of all that they are doing at Watson House.

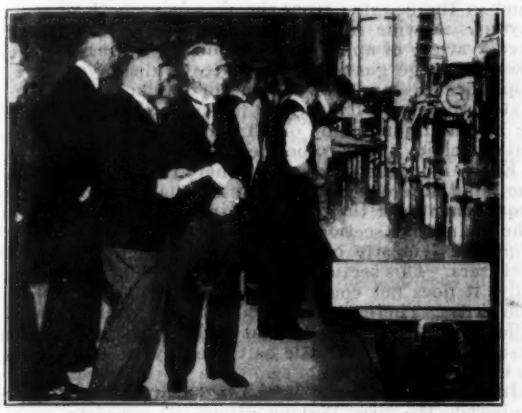
We assembled in the main demonstration room, which has been set out as a practical summary of the work of Watson House. Little need be said of this exhibition save to mention that everything explains itself, the whole providing an admirable display of the latest domestic appliances in comparison with those of ten years ago. One exhibit, however, is worthy of particular note by reason of its ingenious conception. This is a visual example of how a gas meter is (or should be) fitted to-day in a consumer's house by an expert gasfitter, side by side with a similar apparatus as it might well have been installed by an untrained workman. The latter is really amusing, and, indeed, the fitting was done so inexpressibly badly—with the meter out of alignment, lead pipes flattened at the bends, the main cock fouling the wall, the pressure plug completely inaccessible, and an array of finger prints on the wall which would delight the criminal record department of Scotland Yard—that the services of an expert fitter were required, we understand, to execute the job!

Divided into small parties we subsequently proceeded to tour the premises, led by a uniformed apprentice, from one section to another, in each of which the actual members of the staff concerned in the individual researches explained to us what was being done. Our first port of call was the chemical laboratory, where analyses are carried out of the various products used by the Company for a multitude of purposes. We then witnessed what is being done in an endeavour to improve gas burners, demonstrations being given of the effect of badly designed or adjusted burners. Of particular interest here are the experiments with a view to producing a burner which will not light back; we shall look forward to hearing more about this important development. In this room also the subject of proper ventilation of gas appliances is reviewed, a model " Ventile " being connected to a gauge which registers the pull or down draught caused by wind blowing upon the wall on which it is fixed. A fan provides a splendid gale for this experiment, and the effect of faulty fixing of the " Ventile " is indicated by the gauge.

Experiments on plug-in connectors have as their object the production of an easily operated and fool-proof mechanism. Various types of ignition device, both flint and catalytic, are also under review with the object of providing a thoroughly reliable lighting device for gas appliances. Another section is devoted to the study of governors and thermostats, the latter variously operated by compound rod, bi-metallic strip, or liquid expansion, according to the circumstances of the installation. The advantage of fitting a governor on the supply pipe to a gas cooker is demonstrated by showing how, if a governor is not fitted, the flames from a boiling burner are affected when another burner is ignited. All these demonstrations are so clearly set out that the layman can hardly fail to understand the portent of the work in hand, while the technical man can

fully appreciate the care and thought which are being put into every detail.

The section devoted to gas meters indicates the steady reduction which has been brought about in the size of the casing without lessening the capacity of the meter or the accuracy of its measurement. Various meter tests are carried on here, and particular mention should be made of



Lord Snell Inspecting the Water Heater Department.

the extremely neat manner in which all the pipe connections have been made—a remark which may well be applied everywhere throughout the building where fitting work is visible.

We proceeded next to the lighting section, where we inspected the latest devices for measuring the light outputs of gas lamps and the reflection of light from various bodies. It is clearly shown how complicated parabolic curves are produced, while even those terrible " onion " diagrams are made almost understandable to the uninitiated. A series of revolving mirrors enables the different intensities of illumination from a lamp to be measured at various angles from the light source.

Stores Testing.

A very important section of Watson House is devoted to stores testing. The heat resisting qualities of coloured enamels for gas appliances are studied; lighting glassware is plunged straight from the burner into a tank of cold water; mantles are not only tested with a view to discovering their useful burning life, but also to test their robustness by means of a machine on which they are " jigged " up and down; gas taps are subjected to thousands of movements on an automatic machine and then tested for tightness under air pressure submerged in water; enamels are subjected to enormous indignities from abrasions, acids, and hammer blows to ensure that they will stand up to the hard usage they will receive at the hands of an unsympathetic cook; chromium plating spends a short period in a saline atmosphere equivalent to years of actual use, while flexible tubing is subjected to a kind of tug-of-war as well as a bending test and afterwards examined for gas-tightness before it is finally passed for use on the district. In short, the 12,000,000 fittings used by the Company's 7,000 fitters each year must be tested—metals, rubber, glassware, leather; the list of products which are inspected at Watson House is almost endless, and each product must be up to standard. Over 150 different varieties of brushes, from paint brushes to flue brushes, for instance, are used in the Gas Industry. Watson House tests them all. Even ordinary matches have to be tested before the fitter is allowed to take them out; for a faulty match-head, flying off, might burn a hole in a valuable carpet. And it costs the Company less to prevent a faulty article going out to the consumer than to withdraw it from use after it has gone out. Watson House takes no chances. By means of suggestions, criticisms, and complaints collected from consumers by the Company's salesmen, fitters, and service supervisors and sent in by them to the section, a careful record of all defects in apparatus is compiled, and a recurrence of the trouble is thus avoided.

Passing on to other departments we saw refrigerators being tested in a sealed room, the temperature of which was 105° F., while a similar room is injected with a large proportion of carbon dioxide to test the effect of such an atmosphere upon the proper functioning of a gas fire burning therein. Gas fires are carefully examined and a thermopile attached to a revolving arm measures the radiant heat emitted at various angles. The carbon monoxide content of flue gases is measured by a special recording device.

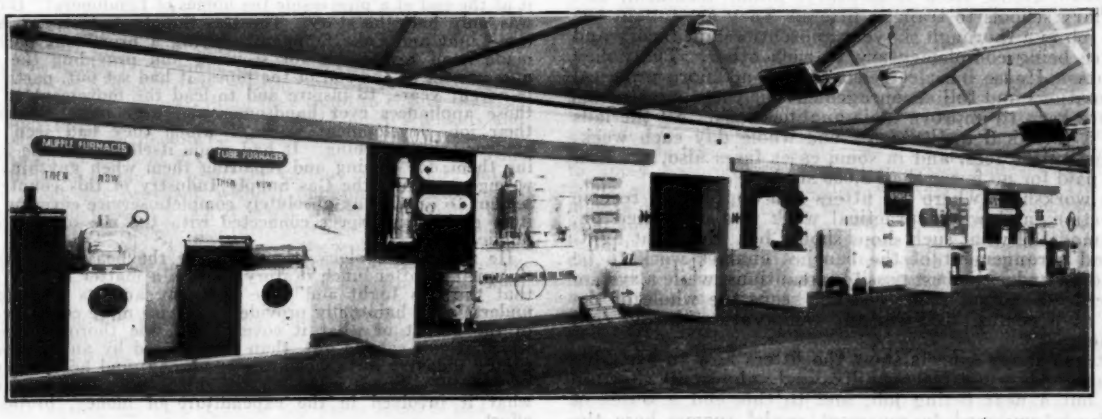
In the cooker department stringent tests are again carried out with a view to finding out the useful life of the apparatus. The equivalent of a year's work is extracted from the cooker in one week, and experiments are also concerned with lessening the heat losses from ovens. The strength of the glass doors of cookers is also an important consideration, and the fact that a suitable material has been produced was ably demonstrated with the assistance of our guide's number eleven boot.

Adjoining the cooker testing section is the research kitchen. It is quite as important to ensure that the recipes set out in the various cookery books will produce the required dish as it is to ensure the long life of the cooker. Not only are new recipes conceived, we gather, in this research kitchen, but all existing recipes are tested against the thermostat readings of various cookers. In this way, too, the accuracy of the thermostats themselves can be tested under working conditions.

Similar care is taken in the water heater section, special attention being devoted to the perfection of the baffler. The " on and offer " automatically turns the water heater on and off every so many minutes, continuously to destruction. Any weakness in design, material, or function is thus mercilessly shown up and is remedied in consultation between the manufacturers and Watson House. Experiments on condensation in water heaters have led to the elimination of the trouble in various types of appliances, while the new G.L.C. circulator is still being subjected to various tests with a view to improving it further.

The larger apparatus is not forgotten, and a special section is devoted to the study of large-scale cookery appliances for restaurant use and ovens for the baker and pastry-cook. The industrial side, too, has a department of its own, where tests are carried out on various gas-heated furnaces—many of them actually designed at Watson House. A recent example of this is a stereo metal melting apparatus for a large London newspaper office; this has a capacity of 11 tons per hour and is fitted with a new type of gas immersion heater for a double automatic autoplate machine.

Even the staff of Watson House have their hobbies, strange as it may seem, and among these appears to be the keeping of tropical fish. Their excuse for this recreation, however (so they tell us), lies in the fact that they keep them in an aquarium whose gas-warmed water is thermostatically controlled to maintain the temperature at



A Section of the General Display in the Assembly Room. The overhead panel heaters can be clearly seen in this photograph.

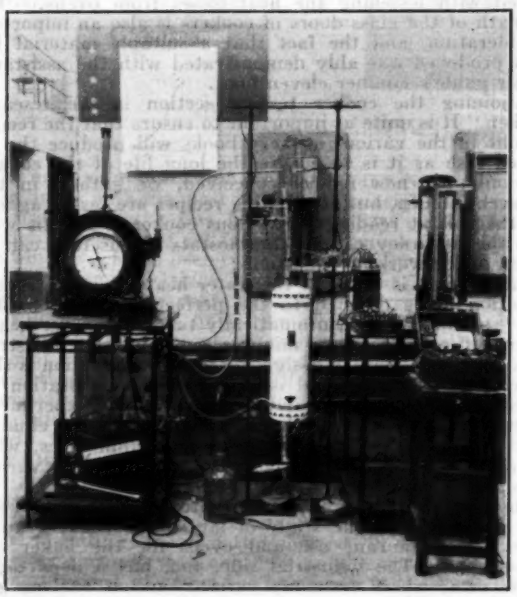
about 80° F.—a heat which, we understand, is favoured by these particular creatures.

It will be appreciated that in a single issue of the "JOURNAL" it would be impossible to do justice to a fraction of the research and testing activities carried on at the new Watson House; but enough has been said to give an idea of the principal lines along which work is at present being directed. It is, perhaps, sufficient to say that the principles of Watson House completely refute the well-known precept of British Justice—a gas appliance, one gathers, is guilty until Watson House have proved it innocent. Indeed, the enthusiasm with which the research staff fall upon a new appliance and, literally, rend it to pieces provides a safeguard for the great gas consuming public the value of which should be better appreciated.

Workshops and Training Centre.

No fewer than 10,000 of the Gas Light and Coke Company's employees come daily into contact with the public, and each one of these has to be specially trained. It takes six years to make a fitter, and, even then, trained fitters return every year to Watson House for a refresher course—a very necessary precaution in view of the rapid development of gas appliances.

At any one time Watson House has no fewer than 250 men in training, and no class contains more than twenty pupils. There are many different courses, from concentrated day refreshers to the four-year course for training public school boys to staff status. Salesmen, service supervisors, and inspectors all have special courses of instruction to suit their own particular requirements.



Research Work in progress in the Hot Water Laboratory on Heat Transference and its Application to Domestic Circulators.

The training of apprentices, though it covers only 10% of the work of the training section at Watson House, is in some ways the most interesting. Selected boys graduate to Watson House from elementary, junior technical, and secondary schools to train as fitters. They are taught the whole job in a thorough six-year apprenticeship, theory and practice being complementary to each other. The policy of Watson House has decreed simpler and more practical examinations and full encouragement for those apprentices who are keen to improve their qualifications. All the lads go to a technical institute for one whole day each week, and institution fees, and in some cases fares also, are now being paid for no fewer than 2,000 students.

The workshops where the fitters and apprentices receive instruction, and where practical work is also carried on, are a model of what such shops should be. Excellent lighting and arrangement of the benches enables work to be carried on under the best possible conditions, while a system of overhead radiant panel heating keeps the whole of the shops at a comfortable working temperature during cold weather.

In these shops experts show the fitters how to assemble appliances, how to trace faults, and, above all, how to carry out a neat fitting job, and to this end a series of cubicles is equipped to represent model rooms; here the fitters have to perform their work under practical conditions and under the watchful eye of an instructor. And around the walls hang appropriate slogans, all pithy and to the point—"A Good Craftsman is a Clean and Tidy Worker. Don't Leave Finger-Marks."

The Industrial Showrooms.

The Industrial Showrooms must be the finest of their kind in the country from the viewpoint both of scope and layout. A wide range of industrial apparatus covering a great variety of applications from surgical instrument sterilizers to large gas-heated furnaces is displayed here, each appliance bearing an explanatory ticket with the price stated thereon. The bright finish of all these appliances, be it aluminium paint or chromium plate, seems to bear out the claim of gas to be the *clean* industrial fuel.

Each manufacturer, and there are more than five thousand different trades in the Company's area, has special requirements for the use of gas in his particular operations. The industrial section, therefore, concentrates on special apparatus—mostly ovens, furnaces, and boilers for manufacturers. This section is concerned with plans and samples only; it does not compete with the manufacturer; it helps him out. There are always between twenty and thirty different experiments on hand in the industrial section; new designs may take as little as three days to perfect, as long as three years.

In addition to the departments which we have here briefly reviewed, the new Watson House is complete with commodious lecture halls and classrooms, a library and conference room, and canteen and recreation rooms, all of which, as in the case of the research and training departments, are laid out on the most up-to-date lines.

In conclusion, a few figures to give an idea of the scope of the new Watson House's activities. The area of the new premises is almost ninety-five thousand square feet; the total staff employed is 882; the number of workmen trained last year was 5,145, and those attending refresher courses 2,987; the number of apprentices in training at Watson House is 69, and the number graduated last year on completion of a six years course was 58. The number of lectures given to refresher students last year was 14,000, while lectures and demonstrations given to outside bodies, including ratepayers' associations, schools, Rotary Clubs, &c., was 44. The number of appliances examined in the Watson House laboratories in 1926 was 50; in 1936, 700. The files of records kept at Watson House in 1926 totalled 3,000; to-day they total 30,000. The technical enquiries dealt with by Watson House Information Bureau each year has reached the enormous figure of 4,000. In short, the New Watson House marks another important milestone on the road of progress.

THE INAUGURAL LUNCHEON.

Following the inspection of the new laboratories, workshops, and training centre, a distinguished gathering, including Lord Snell (Chairman of the London County Council), members of the L.C.C., Directors and Senior Officers of the Gas Light and Coke Company, together with many other representatives of the Gas Industry, were entertained at luncheon—the Governor of the Company (Sir David Milne-Watson) presiding.

The Loyal Toast having been honoured, Sir DAVID drew attention to a certain fact about the British Gas Industry, which, considering how remarkable and unusual it was, had escaped public notice to a surprising degree. The history of the Industry during the last half century, he said, had shown it to be assuming an increasing series of responsibilities towards the community. How much easier life would have been for them to-day if their function consisted in making gas and supplying it at the end of a pipe inside the homes of Londoners! But that was only half the story. The Gas Supply Industry, with the Gas Light and Coke Company playing a prominent part, had made itself responsible for securing and providing the appliances to fix at the end of the pipes; it had set out, particularly in recent years, to inspire and to lead the movement to make those appliances ever handsomer and ever more efficient for their job—development work of which they had seen ample evidence that morning. It had made itself responsible for fixing them, for coming and repairing them when anything went wrong—in short, the Gas Supply Industry of this country had set out to provide an absolutely complete service covering every item and every aspect connected with the use of gas by the public.

He made no apology, therefore, for the boast—expressed in no spirit of after-lunch oratory, but as a matter of cold fact—that the Gas Light and Coke Company and its brother gas undertakings habitually provided a service more complete, both in the extent of what it covered and the thoroughness with which it was carried out, than that offered by any comparable supply industry in this country or abroad; and he was tempted to add that it was provided with little general recognition of what it involved in the expenditure of money, brains, and effort.

Training Work.

The training work was one of the most important of Watson House's activities, went on Sir David, and he gathered that it had proved of particular interest to them during their tour of inspection. They might be interested to know that an important extension of it was proposed in that during the coming year they hoped to establish along the lines of a summer school, at each of which a number of people—perhaps a hundred at a time—drawn from every type of the Company's employees, would be brought to Watson House for a week to pool their experience, discuss their common problems, and review the questions that arose in their work. They would learn from what was to be seen at Watson House and from the expert educationalists on its staff; and Watson House would learn from them something of the enormous variety of problems and points of view that were to be met with among their many separate departments and their 25,000 employees. They wanted thus to make Watson House an intelligence centre and meeting ground for people who would represent every conceivable side of their work, from engineers to service supervisors, from salesmen to gas chemists—and they looked forward with great interest to the outcome of the experiment.

In the Gas Light and Coke Company they had taken the view that those who were in direct touch with the consumer should take an active part in co-operation with the appliance manufacturers in continually inproving appliances and making them serve the needs of consumers better and more cheaply. They had seen fundamental and applied research being carried out there under ideal conditions. It had paid the Company, and it had been to the very great advantage of the public whom they served. He must not spend all his time, however, in talking about Watson House. His purpose in addressing them was to propose the Toast of the London County Council, and he was very glad of that opportunity to tell their County Council guests what warm feelings Mr. Therm, as a good citizen of London, entertained towards them.

The community of London was so vast, said Sir David, that its Government, while municipal in scope, was semi-national in extent. The vast responsibilities resting upon London's Parliament and civil services seemed to grow greater year by year; but the record of solid constructive achievement went on with never a breath of those unwelcome sensations that seemed almost inseparable from municipal life in many other parts of the world. London's governors might complain, as the Governor of the Gas Light and Coke Company had complained, that the full extent and the full significance of the work that they did was too much taken for granted. Just as he was unwilling that their light should be hidden under a bushel, so would he like to do his part in uncovering theirs, and in encouraging them to let it shine more brightly in the view of London's citizens as a whole. If he dared venture a piece of entirely unofficial advice to the London County Council, it would be that the Council should take steps to make the citizens of London better acquainted with what their civic government really involved, and with the vast responsibilities towards them which their County Council undertook. There were few of the major activities of London's governing body in which they of the Gas Light and Coke were not directly interested. They were, of course, particularly concerned with one aspect of their work which had been much in the limelight in recent years—namely, the work of clearing away the slums and the re-housing of London's working-class population. They had not merely followed the achievements of the Council in this regard with pride and satisfaction, but they had themselves been able to play a very extensive part in them. Gas played a substantial part in the provision of essential facilities in every housing block or estate erected under the Council's auspices—a record of which the Company were justly proud.

Keeping Ahead of the Times.

That morning, continued the Governor, they had seen the work they did to keep themselves up to and ahead of the times in the interests of their consumers. He would like to take that opportunity of tendering to the Council and its Officers their assurance that the very best they had in the way of development work and service was at their disposal. The Company wanted to help them in every possible way they could to meet the needs of the working-class community for cheap efficient means of cooking and heating their food and their water supplies. The wanted to work with them in designing and providing the best and most suitable types of appliance for the new kind of industrial dwelling, in the provision of which London was giving a lead to the country and to the world. The Company wanted to do everything they could to ensure that the service they provided was available to the Council's tenants and to the working-class members of the community generally. They wanted to do it at a cost which would enable those consumers to make ample use of all the various health and comfort services which gas provided, without imposing any burden on their household budget which it could not bear, or could bear only at the cost of inroads into their purchase of food and other basic necessities of life. They had seen the work which had been done in enabling people to get a great deal more value in speed, convenience, and actual usable heat out of a therm of gas than formerly.

There was another aspect of what they had seen that he was sure had not escaped them; they inspected the great industrial research laboratories and saw how, one by one, furnaces and other appliances were being designed so as to place gas, in its most efficient form, at the disposal of modern industry. They knew that during the last eight or ten years London had advanced rapidly to the position of being one of the greatest manufacturing cities in the world. New industries covering an enormous range of products had sprung up—a great number of them in the Gas Light and Coke Company's area. All these factories, however diverse their operations, required heat in some form, and nearly all of them needed it in just such a form as gas could provide—exact in control and direct in application. Watson House, therefore, set itself to work out one by one the innumerable variety of furnaces and appliances needed to enable gas to solve satisfactorily the problems of each type of manufacture; and to-day gas played an enormous part in the industrial life of London.

The provision of a controllable smokeless fuel directly applicable to an enormous variety of industrial processes was not merely a service to industry itself, said Sir David; it was a service to the whole community. In saying that he had in mind the vital aim of smoke abatement, with all that it meant to the health and the finances of the country. But he had in mind also another point—that the opening up of this vast new industrial market for gas lightened the burden of their overheads and distribution costs, and so enabled them to supply cheap gas to the whole community, which was a point of particular importance to the working-class consumers.

In conclusion, Sir David expressed once again the great pleasure it gave him and the Directors of the Gas Light and Coke Company to have as their guests the Chairman, the members, and so many of the Officials of the London County Council, and he offered them the Toast of the London County Council, coupled with the name of Lord Snell, the Chairman.

The Interests of the L.C.C.

Lord SNELL, in responding to the Toast, observed that it was a great pleasure to him, as Chairman of the London County Council, to be permitted to open this extension of their activities known as Watson House. He observed that the London County Council was both directly and indirectly interested in

A General View of the Industrial Showroom.

the development of the great service of gas production and distribution. First of all it was in their interest as guardians of the amenities of the citizens of London that they should have at their disposal a cheap and efficient supply of light and heat; the poor consumer should have the best value for his money. Nobody could afford to waste much, but the poor consumer could not afford to waste a penny or even a quarter of it. What they were doing at Watson House was to acquire knowledge to enable the cheapening of production and betterment of quality and to hand that on to the poor people. Secondly, the Council were interested in the idea—the dream—of a smokeless London; they could hardly imagine how beautiful their City would be if it could be seen without the contamination of smoke. The Gas Light and Coke Company helped towards that end, and they should encourage them to carry on with their work and research in this respect. Thirdly, the London County Council were under some obligation to the Company for the example they showed in taking as apprentices so many boys from the London County Schools and giving them a career in this great public service; they could not have observed all those boys working in the shops and Watson House without feeling that they were being trained to become expert citizens for the carrying out of efficient work in the future. Fourthly, they were interested in obtaining the best value for money as guardians of the public treasury and the ratepayers' pockets. They had inspected the Company's extensions that morning, and what they had seen embodied the idea of greater efficiency and safety and the idea of good relationship with the workmen employed in the Industry. The country, as a whole, had been very slow to apply research to industrial processes and slower still to apply science to the amenities of everyday life. The community had entrusted the Gas Light and Coke Company with an important public service, and those responsibilities were being conscientiously acknowledged. As Chairman of the London County Council, in association with his colleagues present on that occasion, Lord Snell thanked the Company for their invitation, and hoped that what they had seen was only the beginning, and that as the days went by more and more of their boys would be passed out as creditable craftsmen of the community. He had the greatest pleasure in declaring Watson House open.

Sir DAVID MILNE-WATSON thanked Lord Snell for opening Watson House and presented him with a souvenir as a memento of the occasion, which Lord SNELL gratefully acknowledged.

The Dilution of Horizontal Coal Gas

by
C. A. DEAS
(Engineer at the Hertford Works of the Tottenham & District Gas Company)

A Paper read before the Southern Association of Gas Engineers and Managers at their General Meeting held at the May Fair Hotel, London, on Friday, Nov. 27, under the Presidency of Mr. R. J. H. CLARK, of Plymouth.

(*Concluded from p. 676.*)

It has been found possible as a result of the use of the Ott burner to add a somewhat greater proportion of water gas to the mixture without causing serious trouble on the district, always providing there is producer gas present. Much work has also been done at the Willoughby Lane Works of the Company in this direction, and by kind permission of Mr. P. C. Gardiner (Chief Chemist) the summary of a Report by the latter, dated April, 1934, on the subject of the "Dilution of Coal Gas by Means of Producer Gas and Water Gas" will no doubt be of interest. It is as follows:

Recent investigations into difficulties experienced in connection with the operation of street lamps drew attention to the different effects of various methods of reducing the calorific value of straight coal gas and focussed attention on the dilution with producer gas. In order to make clear the reasons for these differences it is necessary to recapitulate briefly some of the work.

A convenient criterion of the tendency of a gas to light-back has been found in the proportion of air in the air-gas mixture when lighting back occurs in a particular burner. This is conveniently measured by gradually opening the air port of a bunsen burner, which is consuming the gas at a given pressure, until lighting-back just commences. An arbitrary scale on the air port is related to the proportion of air injected and its indication is thus a measure of the lighting back characteristics of the gas under test. By adopting a scale on which average town gas is approximately 50 (and blue water gas 30), these readings are brought approximately into line with the German Ott numbers, and in the work here presented the term Ott number has been applied to these figures.

A number of special burners have been constructed and calibrated and are in use at various points on the district. In each case a watch is kept for variations in the gas supplied, and it is hoped shortly to have a recording apparatus on the same lines.

A further criterion of tendency towards lighting back is given by the ratio $\frac{C_nH_m + CH_4}{CO + H_2}$ provided that the gas has a calorific value in the neighbourhood of 500 B.Th.U. Higher values of the ratio indicate more satisfactory gases.

Tests with gases of varying Ott numbers used in one of the standard street lamps from the district have shown that when adjusted for a gas of high Ott value, a considerably greater variation can be tolerated without lighting back than when the lamp is set for a gas of low Ott value, and the curve on Graph 1 illustrates this point. The great importance of this discovery lies in the fact that it indicates that Ott numbers should be kept as high as is practicable. Although, the value of the Ott number does not matter so long as it is constant, the practical impossibility of maintaining constancy necessitates the adoption of as high a value as possible, in order to take advantage of the greater tolerance; and it has been found that dilution with producer gas gives mixtures of relatively high Ott number.

A very large number of gas mixtures consisting of varying proportions of horizontal coal gas, carburetted water gas, blue water gas, and producer gas have been experimented with both at Tottenham and Hertford, and special mixtures of gases having calorific values of approximately 500 B.Th.U. have been made. These gases have been analyzed and critically examined for limits of aeration and specific gravity, as well as for their tendency to light back by means of apparatus and burners developed in this laboratory. The results have led to the mixture being placed in the following order of usefulness so far as their tendency to light back is concerned, which is gauged by their respective Ott number.

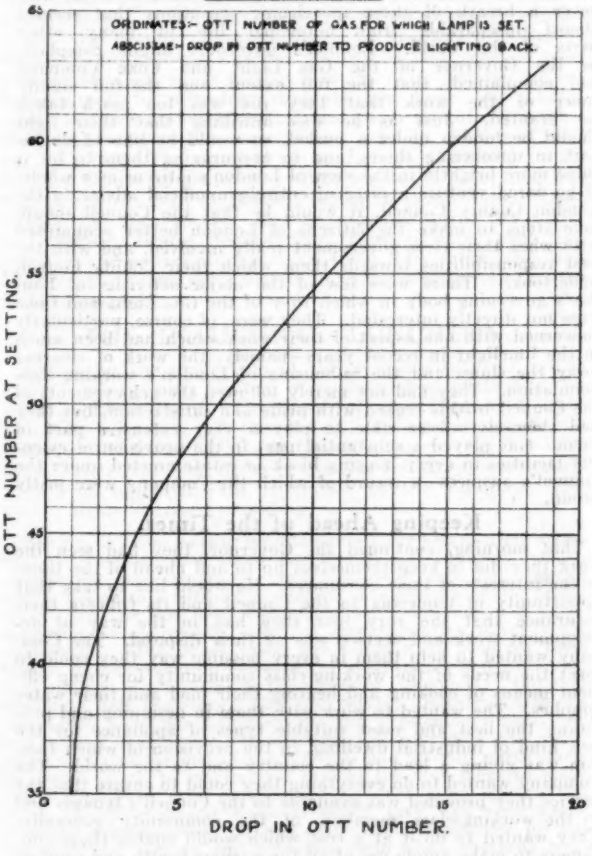
Mixture.	B.Th.U.	Ott No.
Horizontal coal gas and producer gas . .	504	54
Horizontal coal gas and blue water gas .	499	48
Horizontal coal gas and carburetted water gas (380 B.Th.U.)	502	44

From the work of Payman and Wheeler and from our own experimental observation, the flame velocity curves of the constituent gases have been calculated. Ott numbers deduced from these are definitely in the following decreasing order:—

1. Horizontal coal gas.
2. Town gas.
3. Carburetted water gas.
4. Blue water gas.
5. Producer gas.

GRAPH 1.

TOLERANCE TO CHANGE IN OTT NUMBER OF TWO NOZZLE LAMP



It is evident, therefore, that by itself the producer gas is definitely worse than any of the other gases when compared on the basis of the quantity of air which is required for aeration of its flame; but it appears that dilution with this worst gas gives the most satisfactory mixture at 500 B.Th.U. The reasons are, first, that a relatively small quantity of producer gas is required to reduce the coal gas to 500 B.Th.U., and, secondly, that the larger content of carbon dioxide and nitrogen in the mixture after diluting with producer gas tends to lower the upper combustible limit and slow down the velocity of the flame and thus enable rather more air to be used before lighting back occurs.

The following analyses of the three mixtures considered above illustrate these points. The rise in "short flame"

gases with the fall in "long flame" gases and diluents are most marked as one progresses from the high Ott value producer gas mixture to the lower quality blue and carburetted water gas mixture. The drop in the value of the ratio $\frac{C_nH_m + CH_4}{CO + H_2}$ is also well demonstrated.

Gas Mixtures of Approximately 500 B.Th U. Gross.

Mixture.	Horizontal Coal Gas and Producer Gas.	Horizontal Coal Gas and Blue Water Gas.	Horizontal Coal Gas and Carburetted Water Gas.
"Short flame" gases—			
H_2	43·8 } 52·9	47·8 } 62·3	48·4 } 65·2
CO	9·1 }	14·5 }	16·8 }
"Long flame" gases—			
C_nH_m	2·5 } 28·7	2·4 } 25·4	3·2 } 23·1
CH_4	26·2 }	23·0 }	19·9 }
Diluents—			
CO_2	2·4 }	2·9 }	3·5 }
O_2	1·0 } 18·4	0·9 } 12·3	0·9 } 11·7
N_2	15·0 }	8·5 }	7·3 }
$\frac{C_nH_m + CH_4}{CO + H_2}$	0·542	0·408	0·355
Ott No.	54	48	44

The work outlined in this Report was carried out quite independently of that at Hertford, though at about the same time. It does, however, completely confirm the Author's own observations.

For further information on a most important subject, those interested are referred to a Paper on "The Effects of Changes in Composition on the Combustion of Town Gas," to be read by Mr. F. O. Hawes, of the Tottenham and District Gas Company, to the London and Southern District Junior Gas Association on Feb. 12 next.

Gummy Deposits.

No work on producer gas dilution would be complete without some mention of the gum bogey. Does producer gas dilution aggravate gum troubles? From my experience, definitely no.

Producer gas dilution has, as already mentioned, been practised continuously to varying degrees for a number of years. Accepting the nitric oxide theory, gum troubles might be expected to be plentiful. Actually, while it would be wrong to say that we do not have any trouble, I can definitely say that the little which we do appear to get is of minor degree compared with what occurs in other districts. A local district governor was opened up after three years' continuous service, and except for a slight perceptible ring of gum on the valve and seating, was almost as clean as the day it went to work; the writer has knowledge of similar governors on other districts which require to be cleaned every few weeks to enable them to function satisfactorily.

On the Works gum is definitely not a source of difficulty; it is found on governor valves and such like places, but not in sufficient quantities to cause trouble. Certainly it has not necessitated station governors or boosters being opened up from time to time for special cleaning.

It is perhaps necessary to add in this connection that a very high rate of benzole recovery is being practised, varying from 3·3 gallons in the summer months to 3·8 gallons per ton, under favourable conditions, in the winter months, the rate of circulation of wash oil is of the order of 180 gallons per ton of coal.

Before benzole recovery and gas drying were introduced, gum, as it is known to-day, was non-existent. Producer gas dilution was also practised in those days; trouble was, however, experienced when "Dri-Gas" and naphthalene washing was first introduced, but has gradually dropped to the present low level over the past three years. This may be due to the introduction of benzole recovery which has been gradually increased to the present high level over the same period.

It is very difficult, however, to be dogmatic on this latter point. At the time of the introduction of "Dri-Gas" and naphthalene plant, a very much larger proportion of C.W.G. was being sent out than is usual at the present time; in fact, each year with the gradual conversion of the old stop end settings to "throughs" less C.W.G. has been made. At the present time it is only used to take up the winter peak load from about the middle of October until the end of February.

To sum up, producer gas dilution, either practised with or without benzole extraction, does not aggravate gum troubles. The whole secret of this immunity may, of course, lie in retort house operation[4] at Hertford, which, although perhaps not unique, does result in an extremely pure gas from the point of view of the quantity of inerts drawn in from the settings.

Costs.

Any method of production, gas not excepted, must, of course, stand or fall ultimately on its economic value.

The following figures are based on actual costs of gas manufacture at Hertford during the six months ended July 1 last, and show clearly the cost of manufacture using various diluents and, in the case of producer gas, various fuels:

Coal Gas.

Therms per ton (part 10 and part 12-hour carbonizing periods) . 71·7*

	d.	d.
Coal	4·28	
Carbonizing wages	0·40	
Coke loading	0·21	
Purifying (wages and materials)	0·06	
Repairs ,, ,,	0·21	
		5·16
General repairs ,, ,,		0·57
Total gross cost		5·73
Less net residuals—		
Coke, breeze, tar, and benzole		3·14
Net cost per therm		2·59

*Using stock coal part time.

Blue Water Gas (Automatic Set).

Coke Consumption, 33·5 lb. per 1,000 cu.ft. of Gas.

	d.	d.
Coke	1·67	
Breeze (steam raising)	0·15	
Wages (clinkering, pumping syphons, oiling and greasing only). Plant supervised and coked by retort house staff	0·22	
Purification (wages and materials)	0·06	
Repairs (section), wages and materials	0·39	
		2·49
,, (general), wages and materials		0·53
Total cost per therm		3·02

Producer Gas (Using 100% Coke as Fuel).

Fuel Consumption, 13·3 lb. per 1,000 cu.ft. of Gas.

	d.	d.	d.
Coke	1·45		
Steam	0·05		
Wages	0·06		
Purification (wages and materials)	0·06		
Repairs (section) wages and materials	0·17		
		1·79	
General repairs (wages and materials)		0·51	
Total cost per therm			2·30

Producer Gas (Using 78% Breeze and 22% Coke).

Fuel Consumption, 13·5 lb. per 1,000 cu.ft. of Gas.

	d.	d.	d.
Coke and breeze	0·80		
Steam	0·05		
Purification (wages and materials)	0·06		
Repairs (section) wages and materials	0·17		
Wages	0·06		
		1·14	
Repairs (general), wages and materials		0·51	
Total cost per therm			1·65

Producer Gas (Using 14% Coke, 46% Breeze, 40% Slurry).

Fuel Consumption, 14·5 lb. per 1,000 cu.ft. of Gas.

	d.	d.	d.
Coke, breeze, and slurry	0 50		
Wages (clinkering fire)	0·06		
Steam	0·05		
Purification (wages and materials)	0·06		
Repairs (section), wages and materials	0·17		
		0·84	
Repairs (general), wages and materials		0·51	
Total cost per therm			1·35

NOTE.—Coke and breeze are charged up to the water gas and producer gas plants at the lowest price at which they are sold to merchants into vans at works. Slurry is taken as a no-charge item, since it normally incurs cartage to the dump.

Mixed Gas.

Coal/Blue Water Gas.

—	Coal Gas.	Air.	Blue Water Gas.
	%	%	%
By volume	68	5	27
By therms	84	..	16

84% at 2·59d. } 100% = 2·66d. per therm.
16 ,, ,, 3·02d. }

[4] See Paper to Institution of Gas Engineers, "The Formation of Nitrogenous Gum During the Storage and Distribution of Gas."

Coal/Producer Gas.
(Using Coke, Breeze, Slurry mixture.)

—	Coal Gas.	Air.	Producer Gas.
	%	%	%
By volume	77	5	18
By therms	95·7	..	4·3

95·7% at 2·59d. } 100% = 2·54d. per therm.
4·3 ,, ,, 1·35d. }

Coal/Producer Gas.
(Using Coke as Fuel.)

—	Coal Gas.	Air.	Producer Gas.
	%	%	%
By volume	77	5	18
By therms	95·7	..	4·3

95·7% at 2·59d. } 100% = 2·58d. per therm.
4·3 ,, ,, 2·30d. }

Coal Gas/Waste Gas.

—	Coal Gas.	Air.	Waste Gas.
	%	%	%
By volume	82	5	13
By therms	100	..	..

∴ Cost per therm 100% at 2·59d = 2·59d. per therm.

From these figures it will be observed that the coal/producer gas mixture is definitely the cheaper gas—particularly when using low-grade fuel.

For the purpose of these figures I have ignored capital charges. However, if these are taken into consideration, and, of course, they must be when deciding on the relative economies of putting down blue water gas or producer gas plant for *dilution* purposes, the financial advantage of producer gas dilution will obviously be very much more marked. The word dilution is emphasized, since it must be definitely understood that this Paper is dealing with the reduction of the C.V. of straight coal gas. Meeting fluctuations of output is another matter where water gas plant, particularly carburetted, can within limits be shown to have definite economic advantages.

The particular C.W.G. plant used at Hertford is an automatic set, and with the exception of starting up, clinkering, oiling, and greasing, is looked after by the retort house stokers, who also raise the necessary steam. This obviously reacts very favourably towards the cost of water gas manufacture. If the plant was hand operated and also required the services of a boiler man—conditions which are not at all unusual and actually obtained at Hertford prior to the introduction of the auto-operator—the cost of water gas manufacture would be increased by some ½d. per therm. The adverse effect on the final cost of the coal/blue water gas mixture can be readily appreciated.

In connection with the coal/blue water gas mixture it has been assumed that the cost of the coal gas therms would remain the same as with the coal/producer gas mixture, but this, however, may not be the case.

Coal gas manufacture is usually credited with the value of the coke charged to water gas at the lowest price received for any coke sold. Therefore, the more water gas that is made the lower becomes the average price and, of course, the total revenue received from the coke, and up goes the cost of making coal gas. In other words, it is possible to make a cheap blue water gas at the expense of the retort house. This fact assumes that the coke not used for water gas manufacture can be disposed of at a price something above the lowest price received.

The majority of undertakings to-day have, however, little difficulty in disposing of coke at a price which does not justify its conversion to water gas. Many are even finding difficulty in producing sufficient to meet the ever-growing demand for this fuel.

Incidentally, dilution by blue gas would in our case, for instance, reduce the amount of coke for sale by some 1¼ cwt. per ton of coal, not allowing for the possible necessity of having to use coke for steam raising.

It would appear that so long as coal gas therms are *cheaper* to manufacture than water gas therms then producer gas dilution must always be the more economical of the two methods of reducing the calorific value of straight coal gas. With the ever-increasing return from residuals there is little likelihood of water gas becoming generally cheaper than coal gas. There are, of course, exceptions to every rule—*e.g.*, it could be shown that by using producer gas as a diluent in lieu of blue water gas the extra coke available would have to be sold at a very low price to get rid of it, thus more than counterbalancing any saving resulting from the use of producer gas.

One would be ill-advised to generalize on this question of costs, since what might be an extremely acceptable proposition to "A" might be totally unsuited to "B." I would, however, suggest that it is not a difficult matter by putting in the necessary local figures to ascertain whether blue water gas, producer gas dilution, or, for that matter, any other method of dilution, is the more economic proposition.

Conclusion.

Before bringing this Paper to a conclusion, I would take this opportunity of emphasizing the fact that the whole of the work outlined is that of experience obtained over some eight years and not a short experimental period. The technical figures given are those obtained under everyday working conditions in accordance with the standard procedure of the Tottenham Company, and every care has been taken to ensure that they are true records of what has been done.

The cost figures also are as obtained under the normal working of the Tottenham Company's works costing system. Although those given refer in particular to the half-year ended June 30 last, they are typical in so far as they are proportionate to those obtained over a number of years' working.

I have, I feel, gone somewhat at length into this subject in an endeavour to show that producer gas dilution, both technically and economically, is perfectly sound and I really believe a desirable method of dilution. Though I should be very unwise indeed to advocate that it is the salvation of every works dilution problem. Where in particular horizontal retorts only are in use, I do maintain that many such works could with definite advantage adopt this method of dilution.

As Mr. Braidwood remarked last year, there are a large number of undertakings (some 240) in the country which have horizontal retorts only, steaming, even if ultimately shown to be economic, cannot be adopted in all cases—*e.g.*, stop end retorts. Why not then producer gas dilution?

My thanks are due to the Chief Engineer of the Tottenham and District Gas Company for his kind permission to give the information contained in this Paper.

Discussion.

The PRESIDENT, in opening the discussion, remarked that his task in finding a Paper for that meeting was made delightfully easy by the kind offices of Mr. H. C. Smith, to whom he took that opportunity of gratefully acknowledging his indebtedness for putting him in touch with Mr. Deas. To the latter, also, he tendered his own and the Association's best thanks for such a valuable contribution, and one which should give rise to a fruitful discussion. Mr. Deas was to be congratulated upon the success which had attended his systematic pursuit of sound carbonizing principles, in harmony with that flexible outlook which alone could meet the needs of a particular case. A total of 74·6 therms per ton—and mostly washed slacks at that—must surely constitute something of a record for a small horizontal installation. It was clear, moreover, that having produced his straight coal gas so favourably, Mr. Deas was determined to lose no fraction of this advantage by diluting it with any but the most suitable medium. The reduction of calorific value by extensive benzole recovery was doubtless a clearly indicated policy, but the selection of the most suitable diluent was a matter for exhaustive consideration and research. To these Mr. Deas had devoted himself with a diligence and perception which left little doubt as to the logic of his conclusions—at least so far as circumstances at Hertford were concerned.

They were all in search of methods, went on the President, which would provide the cheapest mixed gas therm in a gas designed to give the greatest satisfaction to their consumers. The Author pointed to at least one way of achieving this object under certain conditions. Many would have read with interest the information contained in the previous week's *Gas World*. under the heading of "Current Topics," concerning the detoxification of gas as practised at Hameln by the reduction of the carbon monoxide content to the order of 1%. Few, he imagined, would demur from the desirability of such a practice in principle—particularly as a substantial reduction in sulphur was stated to be among its incidental advantages. If Dr. Gerdes could substantiate his startling claim of a reduction of as much as 50% in the gas production costs, it was clear that all other manfacturing methods would call for a critical review.

Returning to Mr. Deas' Paper, the President observed that he was very interested in his remarks concerning gum deposits. Mr. Deas was very fortunate in his immunity from what he called the "gum bogey," as the phenomenon had bulked as a definitely substantial spectre in the experiences of many of them. When Mr. Clark had been privileged to address the Association in March he had described how a serious position in regard to gum deposits at Plymouth had been relieved by the more frequent complete changing of the wash oil. He had been unable to obtain confirmation of this experience from other works; but he was disposed to think that between the experience of Mr. Deas and himself there was at least some analogy. Mr. Deas stated that the introduction of dehydration and

naphthalene removal was accompanied by gum troubles, but that these were dispersed by intensification of benzole recovery. Since this involved the circulation of as much as 180 gallons of wash oil per ton of coal carbonized, it appeared not unlikely that the relief at Hertford was due to much the same factors as that at Plymouth. There was much food for further thought in Mr. Deas' remarks, said the President in conclusion, but other points would no doubt be dealt with by other speakers in the discussion.

The Demand of the Coke Market.

Mr. G. Le B. Diamond (Folkestone) said that they had been led to this subject by a desire for more coke, the market for which was continually extending. After experiments with their Trefois producer they had approached Messrs. Humphreys & Glasgow, Ltd., who fitted a Meldrum blower to one of their water gas sets. They had only an ordinary town gasholder for storage, which was admirably suited because in it they were able to store approximately eighteen hours' make of producer gas. But this holder threw 10 in. back pressure, so that it required 100 lb. of steam pressure on the blower to lift it. His own figures conformed very closely to the results of the analyses made at Tottenham. The inert content of the town gas was 10%. He could also confirm Mr. Deas' experience in regard to flame propagation and the effect upon lighting burners, though they had not taken out such precise scientific figures. They knew, however, from the tests they had carried out that they did not get a better mantle with the producer gas mixture. Mr. Diamond could also confirm what Mr. Deas had said in connection with viscous tar; they had found that the only thing to dissolve it was hot anthracene oil, and they had overcome this trouble now. He wondered whether Mr. Deas had considered the use of a small suction producer. Altogether, this Paper confirmed the immense advantages to the Gas Industry, and particularly to the smaller undertakings, of amalgamation and grouping, as indicated by the fact that the help and resources of the Tottenham Company had enabled these experiments to be carried through in a way that would not otherwise have been possible.

Mr. F. H. Higton (Dorking) observed that the use of producer gas as a diluent would be of particular value to the small and medium sized works, and his own Company had carried out work in this connection, using the retort house producers. But they had found that the consequent effect upon the producers themselves upset the retort house working rather than the producer gas being effective. They had also installed a Meldrum blower and put the gas into a relief holder through a series of 2 in. cocks for purposes of control. The difficulty of the small works, said Mr. Higton, was that the standard of labour available was not very high, so that the process must be made to consist of more simple actions. Mr. Deas had utilized fines for the purpose of making his producer gas; but Mr. Higton suggested that Engineers of small works would find that, even with the use of coke, the cost of the producer gas was not as low as Mr. Deas had shown, while it must be borne in mind that the percentage added was also very low; they could add about three or four therms to each ton of coal carbonized. The Author had also emphasized that the temperature must be kept at 59° at the outlet of the blower, and Mr. Higton suggested that Engineers must be very careful in measuring this gas, because there could be considerable heat loss on the blower, with the result that fictitious results might be obtained. In his own case the calorific value of the producer gas remained extremely constant at 123 B.Th.U., though a little lower than Mr. Deas'.

It should be appreciated that the rate of make in the generator was not controlled by the diameter of the generator, but by the diameter of the orifice of the steam nipple in the blower. He could obtain 180 therms per ton of coke used in the generator, and there was no apparent labour charge. Those in control of small works knew the value of switching men from one job to another. The capital cost of installing the blower was extremely low; complete with steam pressure reducing valve it was only about £25. They had found, also, that one of the methods of improving the producer gas was to put a plate on the firebars of the producer with a central opening about 18 in. diameter to concentrate the air/steam mixture in the centre of the fuel bed, thus ensuring that it passed through the maximum depth. There were still many works, said Mr. Higton, in conclusion, who believed that over-pulling was one of the methods of lowering the calorific value; it sounded like heresy; but he had seen it done in several instances.

Another Member also confirmed Mr. Deas' results, and observed that one of the most delightful aspects of this process was that one could add the producer gas separately and thus control the pull. It was their endeavour to make their retorts as tight as possible, and it was extremely difficult to control the calorific value by pulling if the retorts were tight; if retorts were to be kept gas-tight, then pressure was the best method. In his case they controlled the calorific value of the producer gas by taking a sample from the main in which the gases were mixed and watching a calorimeter. If the calorific value showed signs of rising they simply added more producer gas; there was no necessity for calculations with this method.

All Anticipated Objections Answered.

Mr. P. C. Gardiner (Tottenham) congratulated Mr. Deas on bringing forward the subject of producer gas dilution, as it was a matter which deserved much more consideration than it had so far received. He thought it would be found that all the anticipated objections to its use were answered in the Paper. Mr. Deas had referred to some research work into the lighting back of burners, which was carried out at Tottenham a few years ago, as the outcome of trouble experienced with a number of public lamps which were situated in such a position that their supply of gas was drawn from two manufacturing stations, and its origin was liable to alternate irregularly. The calorific value was constant, while the variation in specific gravity was insufficient to account for any substantial alteration in the gas rate; but, nevertheless, the lighting varied alarmingly. The cause was traced to the differing proportions of air required for combustion. The numerical gauge of this proportion was referred to as the Ott number, their scale of which was entirely arbitrary and must not be used to compare Tottenham gas with any other. It was gratifying to note that Mr. Deas had found the results of this work confirmatory of his own observations, particularly when it was remembered that the investigation was undertaken from an entirely different standpoint.

There was another point to which he might refer, went on Mr. Gardiner; and that was the high calorific value of his coal gas, upon which so much depended. The figures were so good that he was afraid that they might engender in some minds an element of doubt as to their accuracy. He would therefore like to say that in his capacity of Chief Chemist to the Tottenham Company it had been his duty and privilege to examine the methods of testing adopted at Hertford. Mr. Deas had a complete self-checking system of testing which must be examined to be fully appreciated; it was a model of how reliable testing should be carried out. It therefore gave Mr. Gardiner great pleasure to testify from personal knowledge that all Mr. Deas' test figures could be accepted without any reservation whatever.

Lower Quality Coal Gas.

Mr. S. E. Whitehead (Southampton) observed that in view of all the circumstances the calorific value of Mr. Deas' gas at 645 B.Th.U., before stripping, was on the high side. He left 3½% of volatile matter in the coke. Could not the costs be reduced by making a lower quality coal gas and improving upon the excellent yield per ton? It was possible to make good coal gas at a much lower calorific value than 645 B.Th.U.—which would reduce the cost somewhat. Mr. Deas had made out a very clear case for the use of producer gas in preference to B.W.G. for consumers' appliances; but his composition figures made one pause a little. The effect of mixing this producer gas with the coal gas increased the inert content from about 9·5% when water gas was used as diluent to 17·3% and the specific gravity had risen from 0·492 to 0·523, which in the light of present-day experience was a little retrograde and caused Mr. Whitehead to wonder whether the small savings in the cost per ton were worth while. Were the results in regard to the Ott number partly due to the fact that the producer gas had a lower quality, and a smaller quantity was thus required to dilute to the required calorific value? The financial results depended upon the cost of fuel per therm, and it might be possible to obtain just as good results in the end by making a cheaper coal gas and mixing with blue water gas. Mr. Deas was to be congratulated upon the results he was obtaining from his horizontal retorts and on the way he was tackling the whole business; he was also getting an extraordinarily good yield of benzole, and this figure might be increased still further if the coal gas could be washed before dilution. The absence of producer gas in the benzole washer, said Mr. Whitehead, resulted in a higher concentration and a higher efficiency than was at present being obtained.

Mr. D. B. Parkinson (London) observed that it was important that small works should have some other method of dilution than taking in air. If the fires became low there was a danger of drawing air into the purifiers, which would make the latter liable to catch fire. His undertaking had tried the use of a small suction plant connected to the foul main, which gave very good results. He would be interested to know Mr. Deas' views on the use of producer gas dilution on a small works where it was necessary to shut down at night. Again, on very small works it was difficult to find a producer plant which was small enough.

Mr. G. L. Braidwood (London) said that the first thing that struck him in regard to Mr. Deas' Paper was the remarkable results obtained in the retort house. It occurred to him, however, that the calorific value was unusually high, though he was producing a gas rich in hydrocarbons; his aim was for a high throughput. Whether it was an economic proposition to extract the last therm from every ton of coal was a matter on which opinion was by no means unanimous. Mr. Braidwood was particularly interested in the Author's remarks on the subject of governor control, but he had no doubt that in many works uncontrolled dilution was taking place. Apart from the fact that air was pulled into the retorts the effect on the silica brickwork was deleterious. Short of having a governor on each retort, they could only strike a mean by working a governor to maintain average conditions. It was most unscientific to vary the make and quality by altering the governor pull. Credit was due to Mr. Deas for using a low-grade fuel in the producer, but he ventured to suggest that he was in the fortunate position of being able to get away with it. In his own experience with producers fitted with automatic grates and fuel feeders he had found that one could not keep them going indefinitely with 30% of breeze without trouble occurring; within a few weeks the fires became uneven, and clinker grew up the sides of the producers. It was evident that the smaller the grade of fuel the greater the proportion of tarry deposit in the producer gas; and it was therefore highly desirable to take out everything below ¼ in. In Mr. Deas' fuel 60% was between ¼ and ½ in. and 40% between ½ and ¾ in., which was not a bad size. It had been men-

tioned that the trouble with tarry deposit was not overcome until the temperature of the producer gas was maintained at 120° F. or over, and he would like to ask what the temperature at the inlet of the exhauster was normally. It was not only desirable but necessary to have a producer of sufficient size to enable the control of both quantity and quality of the gas being made, and as regards the choice of diluent one must consider the individual merits of the case. If they were deciding between producer gas and waste gas there was nothing but the difference of specific gravity to be considered; waste gas was obviously the cheapest method, though he imagined that the producer gas/coal gas mixture would be found in the long run to be more advantageous at the burners. Mr. Deas had found that producer gas had not caused any trouble. It was rather risky to dogmatize, for one had to take many factors into consideration, though sufficient was now known in regard to the subject to predict the effect upon the gum problem. Producer gas *per se* might not result in any aggravation of the gum problem, but one must be very careful in considering cases where the producer gas had to be used instead of carburetted water gas. If it was the enrichment of the water gas which supplied the hydrocarbons, the system would be of value in reducing gum, while in a works where benzole extraction was practised it might be useful to retain this in the form of forerunnings.

Mr. R. SUMMERSON (Luton) asked if Mr. Deas could tell them the actual temperature of the retorts or the temperature of the coke as pushed from them and whether he knew the amount of nitric oxide in the producer gas; this might give a clue to the cause of gum formation. He also enquired why it was necessary to dilute at all; Mr. Deas had not stated why he should not distribute straight coal gas.

The Author's Reply.

Mr. DEAS, replying to the discussion, observed that they did not get any gum trouble before, and there was none now. The Meldrum blower would work against a pressure of one-eighth of the initial steam pressure; he had actually worked against 30 in. back pressure. He had not had any experience of a suction gas plant. In regard to the temperature of the steam/air mixture, the remedy was to keep the thermometer as close as possible to the outlet of the blower. He considered that a steam valve was a rather unnecessary refinement. Over-pulling of the retorts tended to make them leaky. They never patched their retorts except occasionally after scurfing, which he put down to the maintenance of a level gauge or slight pressure in the retorts.

Replying to Mr. Whitehead, he observed that it would not be possible in his case to make a cheaper coal gas, in support of which contention he referred them to the Table he had given in the Paper. The coke produced from the 12-hour carbonizing period was unsatisfactory, while that from the 10-hour period gave every satisfaction. He did not think it would be cheaper to make more therms per ton. As regards the higher inert content of the producer gas/coal gas mixture, their tests on lighting burners indicated that they did not get any worse results. Mr. Whitehead had also suggested that he could obtain more benzole; but he was already getting over 90% with an ordinary rotary scrubber. He agreed with Mr. Parkinson that the liability of firing the purifiers was a very real danger on small works. The stokers were often apt to allow the fires to go down, and this would be the result.

If Mr. Braidwood would look at the sketch of the plant he would see that they had a large producer in proportion to the amount of gas they were making. The temperature at the outlet of the exhauster went up slightly, but not very much. In any case, they did not now have the condensing plant after the exhauster, though it used to be at one time; now they cooled the coal gas before the exhauster, subsequently adding the producer gas. Their retort temperatures were usually 1,000° to 1,050° on the 10-hour period and over 1,100° on the 12-hour period; this was on the surface of the retort. In reply to Mr. Summerson's final question, Mr. Deas remarked that their declared calorific value was 500 B.Th.U., which was the reason he could not distribute his straight coal gas at 645 B.Th.U.

Vote of Thanks.

Mr. H. C. SMITH (Tottenham), in proposing a hearty vote of thanks to Mr. Deas for his Paper, said that as one who had been closely in touch with his work during the past few years it gave him great pleasure to do so. His Paper was a model of what a Paper to an Association of this nature should be. He had commenced by giving a description of a plant and process which the majority of members of their Association could apply. They had had many papers in the past describing large plants which would only be used by a few of them; but the plant which was the subject of this Paper was of use to all in that room. And having described the process he had gone on to refer to the effect upon the appliances in which the gas had to be used—a thing which was often overlooked by those on the works. Mr. Whitehead had professed himself to be rather nervous about the specific gravity and the percentage of inerts, but Mr. Smith could assure him that however nervous Mr. Whitehead might be it was nothing compared with his own state of mind when he first discovered what Mr. Deas was doing at Hertford! It had taken the Author a long time to convince him that he was doing the proper thing. He thought it only right to say that Mr. Deas would have carried out his researches whether the Tottenham Company had taken over the Hertford Undertaking or not, though the experience and resources of the Tottenham Company had assisted him to some extent. They were now quite satisfied that he was doing right. All the results at Hertford compared very favourably with those at their other works.

Mr. A. THOMAS (Wellington) seconded the vote of thanks, which was heartily accorded, and Mr. DEAS briefly responded.

Preparing for Coke-Oven Gas

by
J. F. LORD
of Darlington

Paper read before the North of England Gas Managers' Association (Auxiliary Section) at a Meeting held at Newcastle-upon-Tyne on Nov. 28—the PRESIDENT (Mr. J. R. Porter) presiding.

The Darlington Corporation has recently entered into an agreement, whereby the town gas supply will be taken from a new coke oven plant now in course of erection at Willington, approximately 16 miles north-west of Darlington. In view of the importance which the question of coke oven gas supplies to statutory gas undertakings is now assuming, I thought it might be of interest to describe briefly some of the preliminary work involved in preparing for the change-over to coke oven gas. I would emphasize at the outset that much of this work is still in the "on paper" stage, and, therefore, no details as to working or costs can yet be given.

The work to be done includes the laying of the supply main from the coke ovens to the gas-works, the installation of a carburetted water gas plant, with ancillary plant, new exhauster house, extension and re-arrangement of works mains, and a new Lancashire boiler.

The Agreement.

The agreement, which was signed in August, 1935, after lengthy negotiations between the coke oven owners and ourselves, comes into force in April, 1937, and the Corporation contracts to take the whole of its requirements of gas up to a maximum of 4 million cu.ft. per day. It follows on the lines usual in such agreements, with clauses relating to the pressure and quality of the gas, provision and upkeep of the supply main, indemnity against costs or penalties due to deficiency in quantity or quality, "rise and fall" clause for price of gas based on the cost of coal, provision of stock of coal, spare plant at the coke ovens, &c. In some respects it is more elaborate than most agreements, and provision is made for the supply of oven coke at an agreed price delivered to the gas-works for resale by the Corporation, and also for disposal of the make of tar and liquor in the event of our having to resume gas manufacture at the gas-works.

The first move after the signing of the agreement was to apply to the Board of Trade for a Special Order empowering us to take the bulk supply from the coke ovens and also to lay the main outside our limits of supply. The Order was granted in March of this year.

The Supply Main.

The gas will be delivered from the coke ovens in a semi-crude state, all purification subsequent to the inlet to purifiers being carried out at the gas-works, and, therefore, very careful consideration was given to the material and type of joint to be used in the main with a view to guarding against external and internal corrosion and leakage. The gas will be compressed to 20 lb. per sq.in. at the inlet to the main when delivering the maximum quantity of gas. Although, at one time, steel was considered to be the only suitable material for high-pressure mains, recent advances in the technique of centrifugal casting of iron have brought this material into greater prominence, and spun iron pipes are now obtainable with a tensile strength almost twice that of the ordinary sand cast pipe. These pipes also have much greater ductility, thus increasing the resistance to

impact shocks. Nowadays, mechanical joints can be obtained, which are particularly suitable for high-pressure gas mains, and, in addition, are flexible and allow some longitudinal movement of the pipe.

It was, therefore, decided to lay the main, which is 12 in. internal diameter and practically 16 miles long, in Stanton new spun iron pipes with Stanton-Wilson flexible joints. The Stanton-Wilson joint is quickly and easily made by unskilled labour, and has the advantage that no steel, with its liability to corrosion, is used in its construction. The route, which is mainly along public roads, passes through one or two congested areas, and has two crossings over railways and one long crossing over the River Wear. As long spans are necessary, these three crossings are being laid in steel pipes with welded joints. At the River Wear crossing, the main is laid on the caissons supporting the existing road bridge, the maximum span being 62 ft. At one railway crossing, the main is carried alongside a bridge and supported on brackets attached to the stonework of the bridge, and at the other railway crossing the main is supported at each side of the railway, and no intermediate supports are required. Wayleaves have to be paid for each railway crossing, as the main is attached to the Railway Company's property. Although the route is along public roads, the greater portion of the main is in the grass verge with a consequent saving in the cost of laying and reinstatement and less liability to damage from road traffic. The minimum cover is 2 ft. 6 in., but where the main is laid in the carriageway the minimum is increased to 3 ft.

The first eight miles of main from Willington passes through a coal mining area, and to give maximum flexibility in the event of ground subsidence, 12 ft. lengths are used, the remainder being laid in 18 ft. lengths. The syphons are of the ordinary round pot type, with bolted covers to give access to the main where required. From the coke ovens to the River Wear is just over a mile, and the main rises very steeply each side of the river, and, therefore, special large syphons are used in this length, where the bulk of the condensation may be expected. On the two steep gradients the main is fastened to large concrete anchor blocks to prevent slipping and to take the strain off the joints. Valves are inserted every mile to facilitate the testing and purging of the main. These will also be useful in the future for locating and repairing any fault which may possibly develop.

The actual laying of the main, which is now nearing completion, was entrusted to an experienced firm of contractors, and very satisfactory progress has been made, despite a period when supplies of materials fell below requirements, and some of the work had to be closed down. The contractors have had six gangs at work at different points, the average length laid per gang per working week being 270 yd., and a total of 12¾ miles was laid in four months. The main is laid in sections, not exceeding 250 yd. in length and then tested with air at 50 lb. pressure, and the section under test must hold the pressure without loss for a minimum period of three hours before it is accepted as satisfactory. No filling in is done until after the test is completed, and the results have been extremely good, as very few leaks have been found, and these were easily detected and remedied. Pneumatic shovels and road rippers are used where necessary, and petrol rammers for consolidating the trench after filling in. For a short period, a mechanical excavator was used on one stretch where the ground permitted its operation.

Provision has been made for the supply of coke oven gas to two towns *en route*, and at these two points 6 in. branch tees and valves are inserted.

The mainlaying contract includes excavation, laying, jointing, testing, and filling in the trench, but the pipes and specials are supplied by the Corporation, who are also responsible for the final reinstatement of the road surface. Where the main is laid in bad or doubtful ground, it is surrounded by loam or clay, and in one stretch of made up ground the pipes are coated with a ⅛ in. layer of bituminous asphalt as an additional precaution against external corrosion.

All pipes and specials are tested and examined at the makers' works by our inspector, and each pipe is numbered. The number of the pipe is booked on the daily return of pipes laid and a complete record is made of the situation of each pipe.

The Carburetted Water Gas Plant.

Opinions differ as to the necessity of a C.W.G. plant at a gas-works as standby for a coke oven gas supply from modern ovens, but in our case, as the present carbonizing plant consists solely of vertical retorts which could not be brought into operation from cold in less than a fortnight, and also considering the length of the supply main, it was deemed advisable to provide for a C.W.G. plant equal to our present daily maximum output of 2,700,000 cu.ft. This will enable us to resume the manufacture of gas on the works at a few hours' notice, and allowing for the normal stock of gas in the holders, will ensure a full supply for the town at all times.

A contract was, therefore, made with Messrs. Humphreys & Glasgow, Ltd., for a plant consisting of two sections of their latest type carburetted water gas plant, having a total rated capacity of 2,800,000 cu.ft. of 500 B.Th.U. gas per 24 hours. The plant incorporates the three-phase cycle back-run process, and is hand clinkered and hand-operated with operation timing device and cycle counters. As the plant is being installed purely as a standby, and will probably be only infrequently used, it was felt that the fairly heavy capital expenditure necessary for mechanical operation was not at present justified. With a view to incorporating automatic mechanical operation, should future circumstances warrant it, the plant is arranged for easy conversion, the operating floor being specially strengthened so that the necessary alterations could be made with the minimum of expense. Provision has also been made for economical extension in the future, by the addition of a third section of plant. It was thought advisable to install two duplicate sets of half capacity in preference to one larger set, thus reducing the risk of mechanical breakdown causing a complete cessation of gas manufacture at a time when least desired. Each set is complete in itself up to the washer outlet, and the gas stream is then taken to one condenser of a capacity equal to the full make from the two sets. We have an elevated water storage tank on the works at present, and it is intended to utilize this for the condenser cooling water, the water being pumped from the river which passes through the works.

Two blowers, each of ample capacity for the full requirements of the plant, are provided, one being driven by electric motor and the other steam turbine driven. Coke will be taken up to the operating floor in steel charging barrows by means of an electric lift, and coke storage space is provided adjacent to the generator house. From the condenser outlet, the gas passes to an existing ¼ million cu.ft. holder, which will be used as a relief holder when required, and from this holder a new main is being connected up to the exhausters.

Foundations for Water Gas Plant.

The most convenient site for the water gas plant was occupied by a small holder in a brick lined tank, where the ground level was 4 ft. higher than general yard level, probably because the spoil from the holder tank had been dumped on the surrounding ground to save excavation when the holder was erected. Alternative sites were fully considered, as it was realized that elaborate foundations would probably be required, if the holder site were used, but it was finally agreed that the advantages of the site would outweigh any extra cost incurred in foundation work, and as the holder was already derelict, it was decided to dismantle it and utilize the site, provision being made for the ground level to be lowered to that of the surrounding yard level.

The existing brick tank is 72 ft. in diameter, and 16 ft. 3 in. deep from bottom of tank to final ground level. The bottom is formed with a dumpling which has a rise of 8 ft., and is covered with 12 in. of clay puddle. Trial holes were taken through the puddle and the subsoil found to be mainly gravel and quite good. The area covered by the plant and buildings is approximately 70 ft. by 50 ft., so that it was impossible to bring the whole of the foundations within the tank wall, part of the loading coming within the tank, part on the brick wall, and a small portion outside the tank on made up ground. Some of the loads thrown by the plant vessels are heavy, and it was feared that we might have unequal settlement with mass concrete foundations. A firm of reinforced concrete specialists was then called into consultation, and they designed for us foundations embodying a 7½ in. floor slab over the whole area of the tank, on beams 18 in. in depth, which are carried through the tank wall to take the loads outside the tank. The beams are supported by columns which transmit the loads to wide footings on the tank bottom, the whole of the work being in reinforced concrete. The tank will be completely covered by the floor slab, and the whole foundation is tied together at the top by the beams. It is intended to do the work in the following order: The columns and footings will be cast in the tank in its existing condition and concreting will then be suspended until the surrounding ground has been excavated to its final level. The surplus ground will be used for backfilling the tank to the underside of the slab, and beams and floor slab will then be put in.

The buildings are of steel framing, with 4½ in. brick panelling, and special care has been taken to ensure ample light and ventilation. Oil storage is provided by a circular steel riveted tank of 70,000 gallons capacity, which is sufficient for a fortnight's supply when making the maximum quantity of gas.

Lancashire Boiler.

The present steam raising plant consists of three Spencer-Bonecourt waste-heat boilers in the vertical retort house, and two 24 ft. by 7 ft. Lancashire boilers adjacent to the present exhauster house. The C.W.G. plant under full load will require 7,000 lb. of steam per hour, and it was obviously impossible to supply this from the existing plant, as the waste-heat boilers would not be in operation. Two 50,000 cu.ft. per hour gas compressors for supplying gas to our high-pressure ring feeder main are at present under construction, and will shortly be erected, and these will require a further 4,000 lb. of steam per hour. It was, therefore, evident that additional boiler plant was required and consideration was given to the type of boiler to be installed. It would have been possible to make the water gas plant self-supporting as regards steam by the adoption of a waste-heat boiler in conjunction with the plant, but this was ruled out for the following reasons: The waste-heat boiler could be used only with the water gas plant, whereas an independent boiler as an extension of the present works boiler plant would serve as a useful standby to the existing boilers and could be used quite independently of the water gas plant. There is also the difficulty of starting-up. Combined water gas plant and waste-heat boiler plant can be put into operation without the use of any external steam, but considerable care is required or the plant may be damaged, and it would be difficult to exercise the necessary care in the case of a plant likely to be put into operation in the stress and hurry of an emergency. Finally, the cost of waste-heat boiler plant to produce all the steam required by the water gas plant would be considerably in excess of that of a Lancashire boiler for a similar duty.

The existing Lancashire boilers are old and on the small side, and it was finally decided to make use of the present erecting shop for a new boiler house and to install a 30 ft. by 8 ft. 6 in. Lancashire boiler with underground flue connection to the existing stack. The new boiler will have a steaming capacity of 10,000 lb. per hour on good coal, and will generate sufficient steam for the new compressors and water gas plant. Forced draught equipment is included to enable the boiler to be fired with coke breeze during normal times. The new boiler house will accommodate two boilers of this size, and it is intended to install a further boiler at some future date, making the end flue of the new boiler large enough to take the waste gases from two boilers, and to scrap the two existing small boilers.

New Exhauster House and Alteration to Works Mains.

The gas from the vertical retorts passes along a single 18 in. main to the exhausters, and after wet purification it passes in two streams to the two sets of oxide purifiers, and thence to the station meters. The coke oven gas agreement provides for the gas being delivered to inlet to purifiers at not less than 36 in. w.g., which will give ample margin over the pressure required to pass the gas through the purifiers and into holder, and thus the exhauster will not be required. It was thought safer, however, to arrange the connections so that the coke oven gas could be dealt with by the exhausters if desired. To this end, the coke oven gas main is connected directly to the present exhauster inlet, two prior branches being taken off, one of which passes directly to the inlet to one set of purifiers, the other branch leading to the inlet common to both purifiers. It was also necessary to connect the exhausters to a new outlet main from the C.W.G. relief holder. It was impossible to obtain a satisfactory arrangement of the new mains with the exhausters as at present situated, and as accommodation had to be found for the new gas compressors, it was decided to build a larger engine house adjacent to the new boiler site, transfer the exhausters, and have all the engines in one building. The new house will be 55 ft. long by 42 ft. wide by 18 ft. 6 in. to eaves, with a cellar 5 ft. deep, below floor level. The floor will be covered with open steel flooring to ventilate the cellar, and the walls tiled up to the eaves. With the re-arrangement of the mains possible with a new engine house, the exhausters will be able to deal with coal gas from the vertical retorts, coke oven gas, or carburetted water gas, the connections permitting any one gas stream to be kept separate from the other two, and also any one gas stream to be independently metered.

In conclusion, I would mention that contracts have now been placed for most of the work referred to, and I feel sure that when the complete scheme is in operation, it will prove of mutual benefit to the coke oven owners and the gas consumers of Darlington. I would like to take this opportunity of thanking my Chief, Mr. A. E. Ruffhead, for permission to read this Paper and for the interest he has taken in its preparation.

Discussion.

The CHAIRMAN (Mr. J. R. Porter) congratulated Mr. Lord on his Paper, adding that it was quite apparent that laying a 12-in. gas main over 16 miles had not been achieved without considerable difficulties. The Author's description of how they took the main across two railways and a river and over land where mining subsidences were a factor to be considered made the Paper one of considerable value for the archives of the Section.

Mr. J. W. PALLISTER (Middlesbrough) said their choice of spun cast-iron pipes was a wise one. He asked how many syphons were required in the total length of main, and how was the main to be purged of naphthalene. He had had experience of a two-mile length of 20-in. gas main carrying gas from coke ovens, which had quickly been reduced to an internal diameter of only 8 in. by heavy naphthalene deposits.

Mr. A. M. BAGSHAW (Sunderland) asked what precautions were to be taken in respect of the vertical retorts when coke oven gas eventually was taken. How were they proposing to preserve the firebrick portion of the plant which, as was well-known, tended to crumble away when not used? It was proposed to pass the gas from the ovens through purifiers at the works and so into the holders. Had they fully realized the type of gas they were dealing with? The gas would be of a particularly acid nature, and he wondered what steps were to be taken in the purifiers to prevent the acid becoming sour. They had experienced that trouble in Sunderland in the early stages of taking coke oven gas by passing it through the washers and scrubbers where the acid effect was practically neutralized. As to purging the gas main, he did not think they would find much difficulty. They had been surprised at Sunderland at the ease with which this could be done.

Mr. J. R. CLEATOR (South Bank) said that while they were in one of the biggest coke producing districts in Europe, they at South Bank had not yet started to take coke oven gas. He asked Mr. Lord what arrangements his Undertaking had made as to coke prices and how they would be affected under the North-East Coke Association. How did they propose to purify the gas which was to be supplied to the two other towns *en route*? He did not agree with him as to the carburetted water gas plant. It was too small. No doubt they were taking coke oven gas because it was cheaper, and therefore it was likely that because the gas was cheaper the consumption would rise. The plant might not be large enough for the load. It was, he thought, a retrograde step to have hand control, instead of automatic control for quality.

Mr. S. A. WIKNER (Newcastle-upon-Tyne) said a tremendous amount of forethought had been put into the scheme, and it would be interesting if later they could have another Paper from Mr. Lord as to how the scheme had worked out in practice. It had occurred to him that the question of tar disposal was one apt to be overlooked when the coke ovens were concentrated on producing coke and the gas-works on good gas. It had a bearing on industry outside of gas and coke. When a gas-works ceased making gas there was less of the rich tar with valuable residues, and this might account for the increased price of this type of tar. The high-temperature tar from coke ovens was, he believed, almost devoid of these residues. Not, of course, that such a factor was likely for a moment to stop anyone taking coke oven gas, but it was nevertheless an interesting point that was having some financial reaction in certain outside industries.

Mr. F. P. FALL (Sunderland) asked whether the coke oven owners would be responsible for penalties to which the Darlington Works might be subject under the "Inferiority of Gas" clause. Had there been no spun pipes and flexible joints, it would probably have been found that the scheme could have been practicable only with steel mains. What precautions, he asked, had been taken to allow for natural expansion in the metal of the mains due to weather conditions?

Mr. D. YULE (South Shields) asked whether the mechanical diggers had been as efficient in soft clay as in harder ground. He noticed they had laid the mains 3 ft. under the carriage way and 2 ft. 6 in. under grass. Had they any mains under pavement and what depth had they used?

Mr. F. NICHOLLS (Newcastle-upon-Tyne) asked what provision had been made to dilute the gas down to the required quality. Was it to be done at the coke oven or by the gas-works? As to spun pipes, he had heard complaints of them breaking when being drilled and tapped. He thought a $\frac{3}{16}$ in. covering of bitumen was too thin for the pipes. It would have been better to have had thicker protection. What precautions had been taken to ensure that the coke ovens would have an adequate supply of coke in the event of a strike. As to purging, he hoped Mr. Lord would not be too ready to blame the mains. In one case he knew it was the coke ovens that required purging. What precautions had been taken as to the proximity of the gas main and electricity mains?

The Author's Reply.

Replying to the discussion, Mr. LORD said he wished to emphasize that the answers to some of the questions asked were yet to be found by experience, for they were still rather groping in the dark however much they might anticipate problems. They were prepared to deal with these as they arose. He said that the number of syphons in the total length of main would be 45 of a type which would permit them taking off the covers and so getting into the main for purging it. The system also permitted taking up a length of pipe if necessary. They hoped they would not have too much trouble with naphthalene, as naphthalene removal plant was to be put down at the ovens. They had anticipated Mr. Bagshaw's question of trouble in the vertical retorts, and it had been arranged to run the machinery

about once a week, while one retort would have a fire in it. They were also going to keep the temperature of the retort house equitable. As to acid, they could pass the gas over the washers and scrubbers if they got acid trouble. As to purification, they were still feeling their way to some extent. They did not anticipate much waste steam.

Mr. Cleator had asked about the price of coke, and this was provided for in the agreement so that the figure would always be a little less than the local depôt price. They had a good coke market in Darlington, and they wanted to keep it. The carburetted water gas plant was large enough at present for the peak noon load, and there was a reasonable margin. The hand control for control had been decided upon because automatic control was found too costly an installation. The supply of the two towns *en route* was the concern of the coke oven people.

Mr. Fall had asked about the penalty for gas not up to standard. That also had been covered by the agreement, which also provided for an eight weeks' stock of coal at the coke ovens so the works would not be cut off at a moment's notice in case of strike. They had preferred cast-iron to steel pipes because of corrosion. As to their expansion, he found that it was impossible to lay the pipes with the ends flush, and so there was room for expansion. On the bridges, allowance was made for curvature. The mechanical diggers had worked equally well in any type of clay or soil. They had kept to 2 ft. 6 in. under the pavements. He always believed coke oven tar to be rich in residuals. As to dilution, they would have to deal more fully with that, but they did not intend to take the coke oven supply all at once but over a period of weeks, thus providing opportunity of finding out weaknesses. There was now no trouble with drilling spun cast-iron pipes, and a $\frac{3}{16}$ in. bitumen covering was considered to be adequate. They had kept away from electric mains, but twice had got the electric people to divert their cables.

Vote of Thanks.

Mr. FALL proposed and Mr. WIKNER seconded a vote of thanks to Mr. Lord, which was heartily carried.

Select Methods of Chemical Analysis

From a Paper presented to the Manchester and District Junior Gas Association at a Meeting held at Chesterfield on Wednesday, Nov. 11.

by
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Estimation of Phenols.

It is often necessary to determine the quantity of phenols (monohydric) in liquors, oils, &c., and this is carried out by trying to isolate the pure phenols as sodium phenates, and afterwards to estimate these phenates with standard bromine and iodine.

The methods are:

(*a*) Clayton and Skirrow, using lead carbonate.
(*b*) Ulrich and Kather, using benzene and quinoline.
(*c*) Ulrich and Muntz, which is described below.

Ulrich and Muntz Method.

By adding sodium hydroxide and ammonium copper sulphate to the liquor, all ammonium salts are converted into sodium salts, and the sulphide is precipitated as copper sulphide. The sodium phenate is decomposed by CO_2 and the phenols are estimated by $N/_{10}Br$, using Koppeshaar's method.

10 c.c. of the raw liquor (3-5 grammes per litre phenols), 50 c.c. of dephenolated liquor (0·3-0·5 gramme per litre phenols) are taken. 5 c.c. of a 20% solution of ammoniacal copper sulphate and 8 c.c. of a 40% solution of caustic soda are added, and the whole is boiled until no further evolution of ammonia occurs. This removes pyridine, benzene, oils, &c. A steady stream of CO_2 is passed until the solution is saturated, and then the contents of the flask are distilled to dryness and collected in a glass stoppered conical flask.

The collected phenols are acidified with 30% solution (10 c.c.) H_2SO_4 and 25 c.c. $N/_{10}Br$ added. Allow to stand for $\frac{1}{2}$ hr., then add excess KI 10% solution and titrate against standard thiosulphate.

1 c.c. $N/_{10}Br$ = 0·00168 gramme phenols raw liquor.
= 0·0016 ,, ,, dephenolating liquor.

The method is applicable to oils, benzoles, &c. A known weight or volume of the benzole, &c., is taken and extracted with sufficient caustic soda to absorb the phenols present. An aliquot part of the caustic extract is treated with ammonium copper sulphate as before, the solution is boiled, and the phenols are distilled off in a current of CO_2, and estimated by a conversion to tribrome phenols, using Koppeshaar's reagent.

Estimation of P_H Values.

The P_H value is a number which is used to express the active acidity or alkalinity of any fluid. All liquids of which water is a constituent contain free positively charged H ions and negatively charged OH ions. When the numbers of each type of ion are balanced the liquid is said to be neutral. An excess of H ions gives an acid liquid and conversely an excess of OH ions gives an alkaline liquid. The actual concentration of these ions is very small, and the product of the concentrations is a constant known as the constant for water:

$$C_H \times C_{OH} = 10^{-14\cdot14}.$$

and it follows that if one value is known the other can readily be determined. In practice, therefore, we only speak of the H ion concentration, $N/_{10}HCl$ has the H ion concentration (H +) or C_H of $10^{-1\cdot04}$ grammes per litre of ionized hydrogen. $N/_{10}NaOH$ has the H ion concentration of (H +) or C_H of $10^{-13\cdot07}$.

These figures are inconvenient for practical purposes. The basis used is the index of the concentration with the sign changed, and the quantity is known as the P_H.

The above examples give $P_H = 1\cdot04$, $P_H = 13\cdot07$.

Thus the acidity of a solution depends entirely on its hydrogen ion concentration. A neutral liquid has a P_H of 7, an acid liquid has a P_H of less than 7, and an alkali liquid has a P_H of more than 7.

P_H value can be ascertained by means of indicators, several of which are now on the market, and they are available for all the range of P_H value from 4 to 11. This is all that is normally required.

The value of the P_H determination is that small acidities and alkalinities can readily be ascertained. In the olden days methyl orange, phenol phthalene, and litmus were the indicators which were commonly used. In the case of methyl orange the P_H range is 2·9 to 4, which means that a definitely acid liquid of P_H value 5 is alkaline when tested with methyl orange.

The comparator method can be used with clear and slightly turbid liquids. With opaque or dark liquids the electrical method must be adopted. The comparator is useful for testing boiler feed water, condenser water, water from sealing chambers of Woodall-Duckham retorts, coke quenching water, all of which are often acid. It is an important means of boiler feed water control. Acidities can be detected and remedied and much corrosion of iron work prevented.

Estimation of CS_2 in Benzoles and in Coal Gas and Air.

In view of the importance of keeping the organic sulphur in town gas as low as possible, it seems desirable to estimate the quantity of carbon disulphide present in coal gas. When benzole recovery and rectification are practised it is necessary to know the incidence of the total sulphur in the crude benzole, so as to formulate the best scheme of acid washing and rectification.

A method for the estimation of relatively large amounts of CS_2 in benzoles, &c., is given by the Alkali Inspector, in Report No. 72. It consists in formation of the potassium xanthate from the CS_2 by shaking with alcoholic potash and then titrating against standard iodine solution. 100 c.c. of benzole is taken and shaken vigorously with 50 c.c. of 10% freshly prepared alcoholic potash, using pure ethyl alcohol (or a good quality industrial ethyl alcohol, free from pyridine). The shaking should be continued for 1 hr. and then water added, and the potassium

xanthate is found in the aqueous layer. This is separated, and the benzole layer washed three times with distilled water. The whole of the aqueous extract is then just neutralized with acetic acid and then made very slightly alkaline with sodium bicarbonate. An aliquot part is then titrated against standard $N/_{10}$ iodine.

1 c.c. $N/_{10}$ iodine = 0·0076 gramme CS_2.

In the estimation of CS_2 in coal gas or air much smaller quantities of CS_2 are involved, and the method of Callan, Henderson, and Strafford, which is described below, can be used. (This method can also be used for the estimation of CS_2 in benzoles.)

In the case of coal gas, the gas is taken in the $1/_{10}$ cu.ft. bottle (dry) and shaken with 100 c.c. pure benzene free from CS_2.

Method of Callan, Henderson, and Strafford.

Callan and Henderson (*Analyst*, 1929, 54, 650) described the use of sodium diethyl dithiocarbamate as a reagent for the colorimetric determination of small amounts of copper, the reaction depending on the formation of an intense golden brown colour on adding the reagent to a very dilute solution of a copper salt. The same characteristic colour is obtained by using the materials—namely, carbon disulphide and diethylamine—from which the dithiocarbamate is formed. It was noticed that any two reagents formed a sensitive test for the third and preliminary tests indicated the probability that a reagent containing a copper salt and diethylamine will serve as a sensitive method for determining carbon disulphide. Very accurate results have been obtained.

Reagents Required.

1. Benzene freed from carbon disulphide by refluxing with alcoholic caustic potash, diluting and washing with water until free from alkali, separating, drying, and distilling.
2. Standard solution of carbon disulphide.
   (*a*) 1 gramme of redistilled carbon disulphide dissolved in and diluted to 100 c.c. with purified benzene.
   (*b*) 1 c.c. of (*a*) diluted to 100 c.c. with purified benzene 1 c.c. equivalent to 0·0001 gramme carbon disulphide.
3. Diethylamine solution. 1 c.c. of technical diethylamine diluted to 100 c.c. with purified benzene.
4. Copper acetate solution. 0·03 gramme of copper acetate crystals dissolved in 100 c.c. of cold industrial alcohol 64° O.P.
5. Industrial alcohol 64° O.P.

Method of Carrying out the Determination.

Standard comparison solutions are prepared as follows: 0·25, 0·5, 0·75, and 1 c.c. of solution 2 (*b*) are transferred to narrow Nessler cylinders about 1 cm. in diameter, 1 c.c. of diethylamine solution, and 1 c.c. of copper acetate solution are added, and the whole is diluted to 10 c.c. with alcohol. 1 c.c. of solution 2 (*b*) (≡ 0·0001 gramme of carbon disulphide) is the upper limit which can be used, as above this amount the colour is too intense for accurate matching.

1 c.c. of the benzene under test is pipetted into a narrow Nessler cylinder, 1 c.c. of diethylamine solution and 1 c.c. of copper acetate solution are added, and the mixture is diluted to 10 c.c. with alcohol. If the colour is too intense 1 c.c. of the benzene under test is diluted with purified benzene so that 1 c.c. of the diluted benzene will contain from 0·000025 to 0·0001 gramme of carbon disulphide, and the test is repeated.

Having thus ascertained the approximate degree of dilution necessary, fresh solutions are prepared for the accurate comparison, the copper acetate solution being added to the test solution and to the standard comparison solutions at the same time. Each mixture is diluted to 10 c.c. with alcohol and kept for 20 minutes before making the final comparisons.

Accuracy of Method.

Results of independent tests carried out in two of the I.C.I. analytical laboratories:

1.		2.	
% CS_2.		% CS_2.	
Taken.	Found.	Taken.	Found.
0·0033	0·0040	0·0027	0·0023
0·011	0·012	0·0090	0·0092
0·033	0·034	0·0114	0·0107
0·100	0·096	0·068	0·073
0·160	0·160	0·182	0·182

The graduation in intensity of colour of solutions containing increasing amounts of carbon disulphide is very good, and as little as one part of carbon disulphide in one million parts of benzene can be detected.

The method may be applied to commercial samples of benzene containing thiophen, since this produces no colour with the reagent. (Commercial thiophen usually contains carbon disulphide and thus gives a colour; after removal of the impurity by treatment with alcoholic potash, however, no colour is produced.)

The method can be applied to the determination of carbon disulphide in other liquids such as toluene, xylene, carbon tetrachloride, &c.

Estimation of Chlorine in Coal, Tars, &c.

The method is based upon the conversion of all the chlorine in the coal, &c., to a soluble alkaline earth or alkali chloride. 10 grammes of the coal are finely powdered to pass 80 mesh sieve and then mixed intimately with 20 grammes Eschka mixture (1 part Na_2CO_3, 2 parts MgO). The mass is gently incinerated until all the carbonaceous matter is destroyed, using platinum basin and stirrer. The incinerated mass is transferred to a beaker and boiled with 700 c.c. water, the whole filtered, evaporated to 200 c.c., brought to exact neutrality, and the chlorine in the solution estimated by Volhard's method, using potassium chromate as an indicator.

In the case of a tar, similar quantities may be used, but greater care has to be taken to get intimate mixing and also in the incineration, which should not be done in either case above just a visible red heat. The material must not be allowed to fire in the basin.

The mode of occurrence of chlorine in coal is not yet understood. It is believed to be due to presence of sodium chloride derived from infiltrated sea water during the formation of the coal seam. The chlorine usually appears in destructive distillation of coal as ammonium chloride. At the temperature obtaining in the foul mains and collecting mains, this ammonium chloride can dissociate into ammonia and hydrochloric acid, and the iron work of the mains can be attacked by this free acid. A similar action can also take place in tar stills. The recombination of the NH_3 and HCl gives a particulate cloud, which provides nuclei for fog formation in the condensing process. The process of electro-static detarring removes all chlorides from the gas, and subsequent liquor contains no chlorides, while the tar from the detarrer contains a relatively large amount of chlorides.

Discussion.

The PRESIDENT, in opening the discussion, said that it was essential that there should be a competent technical staff on every gas-works and the contribution made by the chemist towards the efficient running of the various processes was recognized by the engineer and manager.

Mr. ALLEN (Droylsden) noted in the Paper that the estimation of phenols is carried out by trying to isolate the pure phenols as sodium phenate. Why did Mr. Albinson use the word "trying"? Was it because he considered the methods described in the Paper left room for improvement? The Paper did not mention the use of the capillator method in connection with the estimation of the P_H value, but it was so useful that it was worthy of mention. By this method the P_H value could be determined not only accurately, but quickly, for a test could be completed in about two minutes. Slightly coloured fluids might be tested without the use of a compensating device, and the P_H value of very dark coloured liquids might be determined with the aid of a compensating device. With regard to boiler water, the P_H value of water sampled from a boiler should be regarded as nothing more than a useful guide. A sample of water taken from a boiler might have a P_H value above 9, indicating that it might not be corrosive, but the total alkalinity should also be determined, as this might be excessive. The question of chlorine in coal recalled a case of a washed coal containing an excessive amount of chloride. The matter was investigated, and the chloride was found as sodium chloride in the water used in the washer.

Mr. W. HODKINSON (United Kingdom Gas Corporation), in regard to P_H value, asked Mr. Albinson whether he had any experience of gasholder water, for it was usually found to be acid?

Mr. ALBINSON, replying to the discussion, stated that holder water with a P_H of 7 was definitely on the acid side. A micro method of estimating the phenols at Partington was now being developed. In reply to Mr. Allen the word "trying" was hardly the right word. The method adopted was quantitative.

Mr. HODKINSON proposed a vote of thanks to Mr. Albinson for his Paper, and Mr. CARTLEDGE seconded.

The Tale of the Rates

Interesting Analysis of Municipal Rating

We are once again indebted to the Preston Borough Treasurer (Mr. W. Allison Davies) for his Annual Statement—the 52nd of the series—which concisely sets out the various rates levied in 343 municipal areas throughout England and Wales, together with interesting details regarding the appropriation of the rates for the different municipal services, totals of populations, rateable values per head of population, and particulars relating to gas, electricity, and water supplies.

Though superficially the analysis presents a rather alarming mass of figures, a closer study of this "tale of the rates" reveals an absorbing story, disclosing the general trend of municipal affairs throughout the country. While the figures of rates levied in the pound must not be taken as necessarily indicative of the actual burden imposed upon the ratepayer in comparison with the corresponding figure for another town, they do, nevertheless, when set against the previous year's figures, demonstrate the general tendency in the areas concerned; for where the figure in the pound may be high, the rateable values may be low, and *vice versa*.

As we have said, the real significance of the statistics set out in the statement can only be fully appreciated by comparing them with those of the previous year—and this occupation makes sad reading, unless it be an indication of an all-round improvement in municipal services. In short, the statement of rates levied in the vast majority of the municipalities included in the present return paints, from the ratepayers' viewpoint, an even gloomier picture than its predecessor. No less than 62% of the towns covered by the statement record increased rating; little over 7% show any improvement—the remaining 30% or so maintaining their previous figures in the pound.

Of the 28 Metropolitan Boroughs included in the return, 21 show an increase, Poplar still being the highest figure with a rise of 8d. to 18s. in the pound. The lowest figure is that of Westminster at 9s. 11d.—an increase of 5d. over last year's figure.

In the 84 County Boroughs dealt with, the average rate has increased from 12s. 11¼d. to 13s. 1¼d. Merthyr Tydfil still maintains the highest figure, having increased again by 7d. to 29s. in the pound; and Bournemouth again occupies the other end of the scale with a rate of 7s. 7d. Of the County Boroughs, eight record a decrease, and 40 an increase. The number of Boroughs included in the return totals 140, and their average rate has increased from 11s. 9⅞d. to 12s. 1⅞d.—ten towns showing decreases and 88 increases. Again a South Wales town heads the list—Port Talbot, with a figure of 19s. 8d. in the pound—while Hove still shows the lowest figure at 7s. 9d. It is interesting to note that Jarrow, last year's highest figure, has dropped its rate by 1s. in the pound to 18s. 6d. Of the 91 Urban Districts in the return, 65 show increases and only 7 decreases, the average rate having increased from 13s. 4¼d. to 13s. 9⅞d. Once again a South Wales district shows the highest figure—Abertillery at 28s. in the pound—though it must in justice be said that this town has decreased its rate by 1s. to reach this level. At the other end of the scale Exmouth has displaced Woking by 1d. with the lowest figure of 9s. 2d. Throughout the statement the figures for many South Wales towns still speak all too eloquently of the distressed conditions which continue to prevail in this area.

Among the particulars of domestic supplies, the return gives the prices of gas per therm and per 1,000 cu.ft. within and without the individual districts, together with the declared calorific value of the gas supplied. Other details of interest are the estimated transfers from municipal undertakings to the relief of the rates, and, conversely, the estimated transfers *to* municipal undertakings in respect of deficiencies. It is gratifying to be able to find but four of the latter, so far as gas undertakings are concerned, throughout the whole of the return, and these appear to make a total charge upon their rates of a mere £4,282, as compared with five undertakings with a total of £7,633 last year. On the other hand, nineteen municipal gas undertakings contribute an aggregate sum of over £117,000 (estimated) to the relief of the rates—the Nottingham Gas Department still being the most generous in this respect with its estimated quota of no less than £31,500. In this connection it should be stated, however, that the statement is not intended to demonstrate the desirability or otherwise of municipal trading. Indeed, the large majority of municipal gas undertakings continue to direct their profits towards improved service and lower charges for their commodities.

Many other interesting facts and comparisons can be gleaned from the statement; suffice it to say, however, that a very profitable study may be made of Mr. Allison Davies' instructive figures.

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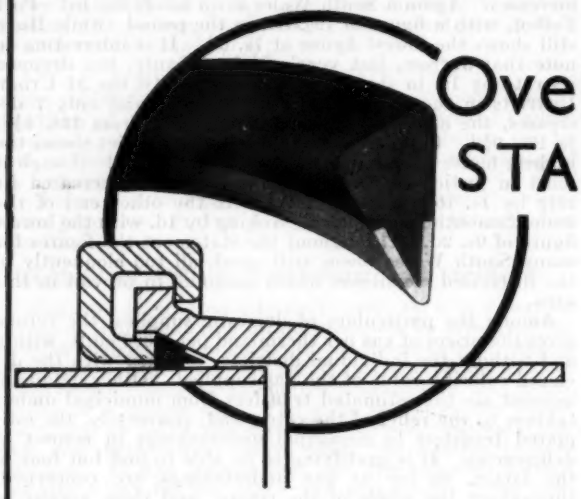

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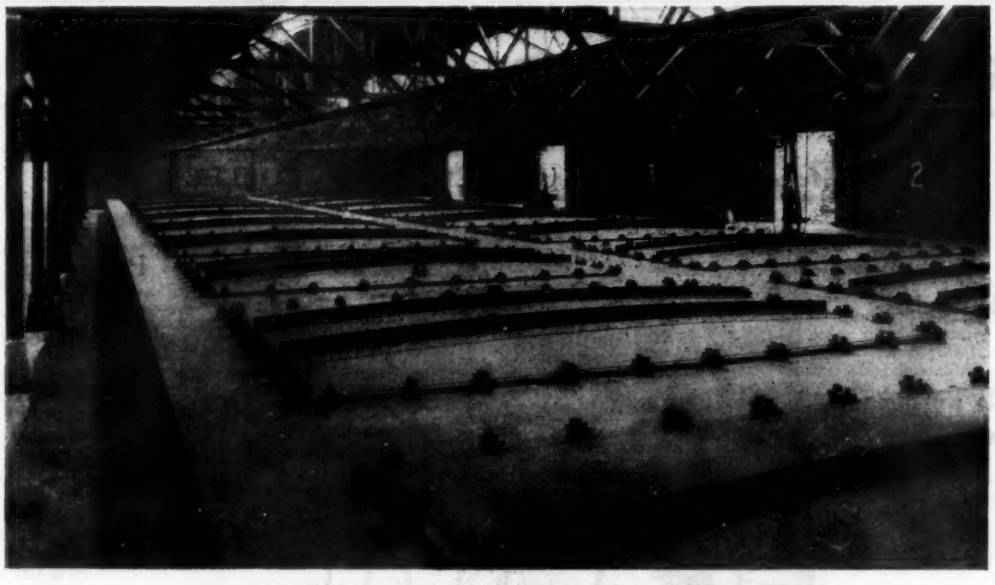

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Gas Markets and Manufactures

Stock Market Report

(For Stock and Share Lists, see later pages)

The usual political disturbances abroad were completely overshadowed last week by the constitutional crisis at home. In the absence of definite news, business on the Stock Exchange was reduced to very small dimensions and quotations were lowered substantially. This marking down was done solely to discourage any large selling movement, though after the first shock was over the lower levels attracted quite a considerable number of buyers. As was inevitable, the gilt-edged section bore the brunt of the situation, business at one time being merely nominal, and, though some recovery set in towards the close of the week, prices in no instances reached their former levels. Home rails were doubly affected, for not only did they suffer considerably in the general marking down, but this was accentuated by adverse traffic returns. Industrials, though recovering somewhat from the initial set-back, were generally without support. It is evident that markets are ripe for a swift change-over to more active conditions when the present uncertainty has been removed.

Gas stocks and shares led an almost normal existence, being singularly unaffected by the situation, and the volume of business was only a trifle less than a week ago. It is true that in several instances the prices of recorded transactions were at slightly lower levels, but the reactions were not serious enough to alter the quotations. Apart, therefore, from a few *ex* div. reductions the only falls of note in the Official List were those of Imperial Continental, which dropped 4 points to 145½, and South Metropolitan with a fall of 2 to 114½. It is satisfactory to note that the Gas Light and Coke Company's new 3¾% preference stock, recently issued at par, has been in good demand and closed on Friday at 1¼ premium.

There was only one change in the Provinces, that of Liverpool ordinary, which fell 3 points to 132-134 on the local Exchange, though business was recorded at 134-135½. In the Supplementary List, several parcels of Oxford and District ordinary changed hands, and the nominal quotation rose 5 points to 220. It will also be seen that a transaction in Wakefield ordinary was put through at 147, the quotation remaining unchanged at 142½.

Current Sales of Gas Products

The London Market for Tar Products.

Dec. 7.

The following prices are at present ruling in the Tar Products market:

Pitch, nominal, at about 34s. per ton f.o.b.
Creosote, about 5¾d.
Refined tar, 3¾d.

Pure toluole, 2s. 4d.; pure benzole, 1s. 7d. to 1s. 8d.; 95/160 solvent naphtha, about 1s. 7d.; and pyridine is still firm, the price for 90/160 being about 7s. All prices are per gallon naked at makers' works.

Tar Products in the Provinces.

Dec. 7.

The average prices of gas-works products during the week were: Gas-works tar, 18s. 3d. to 23s. 3d. Pitch—East Coast, 31s. to 33s. f.o.b. West Coast—Manchester, Liverpool, Clyde, 31s. to 33s.* Toluole, naked, North, 1s. 11d. to 2s. Coal tar crude naphtha, in bulk, North, 8d. to 8½d. Solvent naphtha, naked, North, 1s. 4d. to 1s. 5d. Heavy naphtha, North, 1s. 1½d. to 1s. 2½d. Creosote, *ex* works, in bulk, North, liquid and salty, 4¾d. to 5d.; low gravity, 4½d. to 4¾d. Heavy oils, in bulk, North, 5d. to 5¼d. Carbolic acid 60's, 2s. 7d. to 2s. 8d. Naphthalene, £18 to £20. Salts, 90s. to 95s., bags included. Anthracene "A" quality 4½d. to 4¾d. per minimum 40% purely nominal; "B" quality, unsalable.

* All prices for pitch are now quoted on the basis of f.o.b. In order to arrive at the f.a.s. value at any port it will be necessary to deduct the loading costs and the tolls whatever they may be.

Tar Products in Scotland.

GLASGOW, *Dec.* 5.

With the exception of creosote oil there has not been a great deal of business placed during the week. Prices of all products, however, are well maintained.

Crude gas-works tar.—The actual value is 34s. to 35s. per ton *ex* works in bulk.

Pitch remains a dull feature at 30s. to 32s. 6d. per ton f.o.b. Glasgow for export, and 30s. per ton *ex* works in bulk for home trade.

Refined tar is still available at 3d. per gallon f.o.r. for export, and 3¾d. per gallon *ex* works in buyers' packages for home trade.

Creosote oil.—Prices are steadier than they have been for some weeks, and the following values can be taken as minimum for reasonable quantities: Specification oil, 4¾d. to 5d. per gallon; low gravity, 4¾d. to 5d. per gallon; neutral oil, 4½d. to 4¾d. per gallon; all ex works in bulk.

Cresylic acid.—Production is well looked after and prices are round the following: Pale, 97/99%, 2s. 5d. to 2s. 7d. per gallon; dark, 97/99%, 2s. 2d. to 2s. 4d. per gallon; and pale, 99/100%, 2s. 9d. to 3s. per gallon; all *ex* works in buyers' packages.

Crude naphtha.—A small but steady business is being conducted at 5½d. to 6d. per gallon *ex* works in bulk, according to quality and district.

Solvent naphtha.—90/160 grade is relatively quiet at 1s. 4½d. to 1s. 5d. per gallon, and 90/190 heavy naphtha at 11d. to 1s. per gallon.

Motor benzole can be secured in fair quantities at 1s. 2½d. to 1s. 3d. per gallon.

Pyridines.—Supplies being scarce prices are nominal at 6s. to 6s. 6d. per gallon for 90/160 grade, and 7s. to 7s. 6d. per gallon for 90/140 grade.

Benzole Prices.

These are considered to be the market prices for benzole at the present time:

	s.	d.		s.	d.	
Crude benzole	0	8½	to	0	9	per gallon at works
Motor "	1	2	"	1	2½	" " "
90% "	1	3	"	1	3½	" " "
Pure "	1	7	"	1	7½	" " "

Contracts Advertised To-Day

Benzole (Crude).
Stoke-on-Trent Gas Department. [p. 751.]

Coal.
Coalville Urban District Council. [p. 752.]
Market Harborough Gas Department. [p. 751.]
Penrith Gas Department. [p. 752.]

Coal and Coke Handling, &c., Plant.
Hebden Bridge and Mytholmroyd Gas Board. [p. 752.]
Stockport Gas Department. [p. 751.]

Condensers.
Brigg Gas Department. [p. 752.]
Keighley Gas Department. [p. 752.]

Meter Station.
Brigg Gas Department. [p. 752.]

Retort Installations (Vertical), &c.
Hebden Bridge and Mytholmroyd Gas Board. [p. 752.]
Stockport Gas Department. [p. 751.]

Scrubbers, Washer Scrubbers, &c.
Brigg Gas Department. [p. 752.]
Hebden Bridge and Mytholmroyd Gas Board. [p. 752.]
Keighley Gas Department. [p. 752.]

Tar Extractor and Ammonia Washer.
Hebden Bridge and Mytholmroyd Gas Board. [p. 752.]

Gas Undertakings' Results

Chertsey.

The Directors of the Chertsey Gas Consumers' Company report that the accounts of the Company for the year show that after paying in respect of the March half-year dividends at the rate of £6% on the 6% preference stock, £6% on the 5% standard ordinary stock, £8% on the 7% standard ordinary stock, and £11% on the 10% standard ordinary stock, and after charging interest on debentures and loans, and income-tax, there was a total available balance of £10,052, out of which the Directors recommend the payment of the following dividends in respect of the September half-year—viz.: On the 6% preference stock at the rate of £6% per annum; on the 5% standard ordinary stock at the rate of £6%; on the 7% standard ordinary stock at the rate of £8%; and on the 10% standard ordinary stock at the rate of £11% per annum, which would absorb the sum of £1,565, leaving £8,487 to be carried forward to the credit of the current year. The sales of gas show an increase of 69,260 therms, equal to 11·16% over the previous year. The revenue account showed an income of £44,225, made up of: Sale of gas £30,186, rental of meters, stoves, &c., £4,790, and residual products £9,067 (coke £7,665, and tar £1,190). The expenditure included: Manufacture of gas £23,013, distribution £8,384, public lamps £964, rents, rates and taxes £842, management £2,562, and miscellaneous £1,701, leaving a balance of £6,759. The net revenue account showed receipts amounting to £14,403, the balance of which (£10,052) was carried to the next account. The statement of gas made, sold, &c., showed that 161,785,200 cu.ft. (784,237 therms) were made. Of this quantity 5,379,400 cu.ft. were used in public lighting, and 137,034,600 cu.ft. by private consumers, making a total sold of 142,414,000 cu.ft.

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STOCK AND SHARE LIST

Official Quotations on the London Stock Exchange

Issue. £	Stock or Share	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations Dec. 4	Rise or Fall on Week	Transactions, Lowest and Highest Prices During the Week.
1,767,439	Stk.	Sept. 7	7⅞	8	Alliance & Dublin Ord. ...	167—172	...	...
374,000	,,	June 22	4	4	Do. 4 p.c. Deb. ...	94—99	...	...
557,655	,,	Aug. 10	7	7	Barnet Ord. 7 p.c.	168—173	...	171—171½
300,000	1	Oct. 5	1/9½	1/4½	Bombay, Ltd.	26/—28/-	...	27/3—27/6
179,305	Stk.	Aug. 10	9½	9½	Bournemouth sliding scale ...	220—230	...	...
590,407	,,	,,	7	7	Do. 7 p.c. max. ...	168—173	...	174—175
493,960	,,	,,	6	6	Do. 6 p.c. Pref. ...	148—153	...	151
50,000	,,	June 22	3	3	Do. 3 p.c. Deb. ...	85—90	...	...
262,025	,,	,,	4	4	Do. 4 p.c. Deb. ...	105—110	...	...
335,000	,,	,,	5	5	Do. 5 p.c. Deb. ...	125—130	...	...
357,900	,,	Aug. 10	7½	7½	Brighton, &c., 6 p.c. Con. ...	168—173	...	170
649,955	,,	,,	6½	6½	Do. 5 p.c. Con. ...	153—158	...	155
205,500	,,	,,	6	6	Do. 6 p.c. 'B' Pref.	145—150	...	...
855,000	,,	Oct. 5	8	7	British Ord.	157—162	...	160—162
100,000	,,	June 8	7	7	Do. 7 p.c. Pref.	151—156	...	...
350,000	,,	,,	5½	5½	Do. 5½ p.c. 'B' Cum. Pref.	108—113	...	...
120,000	,,	,,	4	4	Do. 4 p.c. Red. Deb. ...	95—100	...	...
450,000	,,	,,	8	5	Do. 5 p.c. Red. Deb. ...	110—115	...	...
200,000	,,	,,	3½	3½	Do. 3½ p.c. Red. Deb. ...	100—103	...	...
100,000	10	22 May '33	6	4	Cape Town, Ltd.	1—3	...	...
100,000	10	6 Nov. '33	4½	4½	Do. 4½ p.c. Pref. ...	1—3	...	...
150,000	Stk.	June 22	4½	4½	Do. 4½ p.c. Deb. ...	80—85	...	...
626,860	,,	July 20	6	6	Cardiff Con. Ord.	128—133	...	...
237,860	,,	June 8	5	5	Do. 5 p.c. Red. Deb.	108—113	...	...
98,936	1	Oct. 19	2/-	2/-	Colombo Ord.	1⅞—1¾	...	...
24,510	1	,,	1/4½	1/4½	Do. 7 p.c. Pref. ...	23/6—25/6	...	...
609,204	1	Oct. 5	-/11·48	-/11·48	Colonial Gas Assn. Ltd. Ord.	17/6—19/6	...	...
296,053	1	,,	1/3·30	1/3·30	Do. 8 p.c. Pref.	21/—23/-	...	...
1,775,015	Stk.	Aug. 10	5	5	Commercial Ord.	93—98	...	93—94½
620,000	,,	Nov. 30	3	3	Do. 3 p.c. Deb. ...	83—88*	1	...
286,344	,,	Aug. 10	5	5	Do. 5 p.c. Deb. ...	122—127	...	...
807,560	,,	Aug. 10	7	7	Croydon sliding scale ...	158—163	...	160—162½
644,590	,,	,,	5	5	Do. max. div.	115—120	...	118
620,385	,,	June 22	5	5	Do. 5 p.c. Deb.... ...	125—130	...	125
239,000	,,	Aug. 10	5	5	East Hull Ord. 5 p.c.... ...	108—111	...	...
184,555	,,	Aug. 10	6	6	East Surrey Ord. 5 p.c. ...	128—133	...	...
176,211	,,	June 8	5	5	Do. 5 p.c. Deb. ...	123—128	...	127
250,000	1	Nov. 16	4	4	Gas Consolidation Ord. ...	20/6—22/6	...	...
250,000	1	,,	4	4	Do. 4 p.c. Red. Cum. Pref.	19/—21/-	...	20/3
19,284,128	Stk.	Aug. 10	5⅜	5⅜	Gas Light & Coke 4 p.c. Ord.	26/—27/-a	...	26/—26/9
2,600,000	,,	,,	3½	3½	Do. 3½ p.c. max. ...	89—92	...	...
4,477,106	,,	,,	4	4	Do. 4 p.c. Con. Pref. ...	105—108	...	105—107½
8,602,497	,,	Nov. 30	3	3	Do. 3 p.c. Con. Deb. ...	84—87*	−2	84—86⅛
3,642,770	,,	,,	5	5	Do. 5 p.c. Red. Deb. ...	115—118*	−2	116½
3,500,000	,,	,,	4½	4½	Do. 4½ p.c. Red. Deb. ...	114—117*	−1	114—115
700,000	,,	Sept. 7	...	25/5§	Do. 3½ p.c. Red. Deb. ...	102—10	...	103—104
270,466	,,	Aug. 24	6	6	Harrogate New Cons. ...	128—133	...	...
213,200	,,	Aug. 10	6	6	Hornsey Con. 3½ p.c. ...	133—138	...	...
5,600,000	,,	Nov. 2	12	8	Imperial Continental Cap. ...	143—148	−4	143—151
223,130	,,	July 20	3½	3½	Do. 3½ p.c. Red. Debs.	92—97	...	...
285,242	,,	Aug. 24	8½	8½	Lea Bridge 5 p.c. Ord. ...	183—188	...	...
11,751	,,	,,	10	8	Maidstone Gas 5 p.c. Cap. Stk.	190—200	...	...
63,480	,,	June 22	3	3	Do. 3p.c.Prp.Db.Sk	80—85	...	...
75,000	,,	Nov. 30	†10	†10	Malta & Mediterranean ...	185—195*	−5	...
392,000	—	Oct. 1	5½	5½	Metropolitan (of Melbourne) 5½ p.c. Red. Deb. ...	100—105	...	...
231,978	Stk.	Aug. 24	5	5	M.S. Utility 'C' Cons. ...	110—115	...	...
818,657	,,	,,	4	4	Do. 4 p.c. Cons. Pref.	102—107	...	105—106½
360,075	,,	June 22	4	4	Do. 4 p.c. Deb. ...	104—109	...	...
148,955	,,	,,	5	†5	Do. 5 p.c. Deb. ...	122—127	...	...
125,000	—	July 1	3½	3½	Do. 3½ p.c. Rd. Rg. Bds.	97—100	...	...
675,000	Stk.	Nov. 16	†6	†6	Montevideo, Ltd.	74—79*	...	...
225,000	,,	Aug. 10	7½	7½	North Middlesex 6 p.c. Con.	170—175	...	...
396,160	,,	Aug. 10	5	5	Northampton 5 p.c. max. ...	110—115	...	...
300,000	,,	Nov. 2	†9	†9	Oriental, Ltd....	168—173*	...	...
416,617	,,	June 8	8	8	Plymouth & Stonehouse 5 p.c.	168—173	...	...
504,416	,,	Aug. 10	8½	8½	Portsmouth & Gosport Cons.	178—183	...	...
241,446	,,	,,	5	5	Do. 5 p.c. max. ...	114—119	...	...
73,350	,,	,,	...	5	Do. 5 p.c. Pref. ...	118—123	...	...
363,470	1	Sept. 21	1/-	1/-	Severn Val. Gas Cor. Ld. Ord.	21/6—23/6	...	...
454,510	1	,,	-/10¼	-/10¼	,, ,, 4½ p.c. Cum. Pref.	21/—23/-	...	22/6
133,201	Stk.	Aug. 24	5	8⅛	Shrewsbury 5 p.c. Ord. ...	145—150	...	...
90,000	10	June 8	13½	†4	South African...	4—5	...	...
1,152,635	1	Sept. 7	1/2½	1/2½	South East'n Gas Cn. Ld. Ord.	27/—29/-	...	27/6—28/6
845,511	1	,,	-/10½	-/10½	Do. 4½ p.c. Red. Cum. Pref.	21/—23/-	...	21/6—22/-
200,000	1	,,	4	4	Do. 4 p.c. Cum. Pref. ...	20/6—21/6	...	21/3
150,000	Stk.	Aug. 10	...	3½	Do. 3½ p.c. Red. Deb. ...	100—102	...	...
6,709,895	,,	Aug. 10	6½	5	South Met. Ord.	113—116	−2	113½—117
1,135,812	,,	,,	6	6	Do. 6 p.c. Irred. Pf....	145—150	...	146—148
850,000	,,	,,	4	4	Do. 4 p.c. Irred. Pf....	104—107	...	105½—106½
1,895,445	,,	June 22	3	3	Do. 3 p.c. Deb. ...	86—89	−1	86½—88½
1,000,000	,,	July 6	5	5	Do. 5 p.c. Red. Deb.	114—117	...	...
1,543,795	,,	Aug. 10	6	6	South Suburban Ord. 5 p.c....	130—135	...	131
512,825	,,	,,	5	5	Do. 5 p.c. Pref....	122—127	...	125½
500,000	,,	,,	4	4	Do. 4 p.c. Pref....	102—107	...	...
888,587	,,	June 8	5	5	Do. 5 p.c. Deb....	123—128	...	123
250,000	,,	,,	4	4	Do. 4 p.c. Deb. ...	102—107	...	...
427,859	1	Nov. 16	1/2⅜	9⅜	S. Western Gas & Water Ord.	21/6—23/6	...	21/9—22/-
160,523	1	Oct. 19	-/10½	-/10½	Do. 4½% Red. Cum. Pref.	20/6—22/6	...	...
110,000	Stk.	June 22	4	4	Do. 4½% Red. Deb. ...	100—105	...	...
647,740	,,	Aug. 10	5½	5	Southampton Ord. 5 p.c. ...	112—117	...	...
121,275	,,	June 8	4	4	Do. 4 p.c. Deb.	100—105	...	...
350,000	,,	Aug. 10	5½	5½	Swansea 5½ p.c. Red. Pref. ...	112—117	...	114½—115½
106,000	,,	June 8	6⅛	6⅛	Do. 6½ p.c. Red. Deb. ...	98—101	...	...
94,000	,,	,,	§35/-	3½	Do. 3½ p.c. Red. Deb. ...	95—100	...	...
1,076,490	,,	Aug. 10	6½	6½	Tottenham and District Ord.	152—157	...	154
409,835	,,	,,	5½	5½	Do. 5½ p.c. Pref. ...	130—135	...	131½—132
62,235	,,	,,	5	5	Do. 5 p.c. Pref. ...	120—125	...	...
371,850	,,	Nov. 30	4	4	Do. 4 p.c. Deb. ...	102—107*	−1	...
369,774	,,	Aug. 10	7	7	Uxbridge, &c., 5 p.c. ...	165—170	...	...
108,330	,,	,,	5	5	Do. 5 p.c. Pref.	120—125	...	123—124½
1,340,521	,,	Aug. 10	7	7	Wandsworth Consolidated ...	159—164	...	161½—162
1,371,373	,,	,,	5	5	Do. 5 p.c. Pref. ...	122—127	...	124½—125
500,000	,,	,,	...	...	Do. 4 p.c. Pref. ...	104½—107½	...	106½—107
1,317,964		June 8	5	5	Do. 5 p.c. Deb. ...	127—132	...	129—130
338,300	,,	,,	4	4	Do. 4 p.c. Deb. ...	103—108	...	...
499,735	,,	Aug. 10	7¼	7	Watford and St. Albans Ord.	157—162	...	...
200,000	,,	,,	5	5	Do. 5 p.c. Pref. ...	120—125	...	122
200,000	,,	,,	5½	5½	Do. 5½ p.c. Pref. ...	131—136	...	...
200,000	,,	June 22	4	4	Do. 4 p.c. Red. Deb.	100—105	...	...
100,000	,,	,,	...	3½	Do. 3½ p.c. Red. Deb.	99—102	...	...
158,400	,,	Aug. 24	6b	5½	Winchester W. & G. 5 p.c. Con.	120—125	...	...

a.—The quotation is per £1 of Stock. *b.*—Paid £3, including 10s. on account of back dividends. * Ex div.
† Paid free of income-tax. ‡ For year. § Actual.

Stock and Share List continued overleaf.

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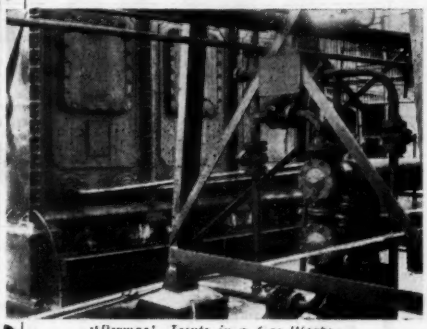
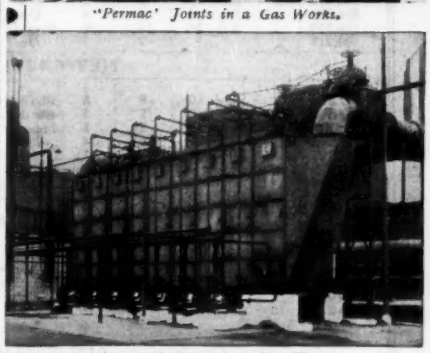
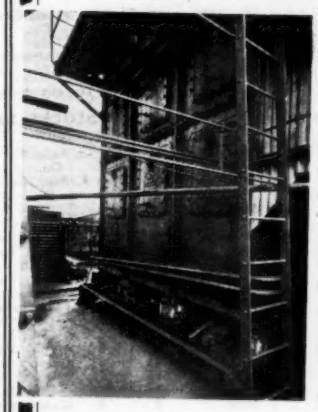


"Permac" Joints in a Gas Works.



"Permac" Joints in a Gas Works.



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STOCK AND SHARE LIST—Cont.

Stocks Officially Quoted on Provincial Exchanges

Issue. £	Stock or Share	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.s.	Dividends. Last Hf. Yr. % p.s.	NAME.	Quotations. Dec. 4.	Rise or Fall on Week.	Transactions, Lowest and Highest During the Week.
BRISTOL EXCHANGE.								
347,756	Stk.	July 20	6	5	Bath Cons.	122½—124½	...	...
1,667,250	,,	July 6	5	5	Bristol, 5 p.c. max. ...	118—120	...	...
120,420	,,	June 8	4	4	Do. 1st 4 p.c. Deb. ...	103—105	...	...
217,870	,,	,,	4	4	Do. 2nd 4 p.c. Deb. ...	103—105	...	...
328,790	,,	,,	5	5	Do. 5 p.c. Deb.	124—127	...	...
274,000	,,	Aug. 10	5	5	Newport (Mon.) 5 p.c. max....	110—114	...	...
13,200	12	Sept. 7	8⅓	7	Pontyp'l Gas & W. 10 p.c. 'A.'	13½—14½	...	...
13,600	10	,,	6	5	Do. 7 p.c. B.'	12—12½	...	...
40,000	10	,,	6	5	Do. 7 p.c.' C.'	12—12½	...	...
140,778	Stk.	Aug. 10	5	5	Weston-super-Mare Cons. ...	112—114	...	...
64,338	,,	June 23	4	4	Do. 4 p.c. Deb.	100—102	...	...
33,340	,,	,,	7½	7½	Do. 7½ p.c. Deb.	163—166	...	...
LIVERPOOL EXCHANGE.								
157,150	Stk.	Aug. 10	6½	5	Chester 5 p.c. Ord.	107—112	...	...
92,300	,,	June 8	4½	4	Do. 4 p.c. Pref.	98—102	...	...
32,540	,,	,,	3	3½	Do. 3½ p.c. Deb. ...	90—95	...	...
41,890	,,	,,	4	4	Do. 4 p.c. Red. Deb. ...	99—103	...	...
2,167,410	,,	Aug. 24	6	6	Liverpool 5 p.c. Ord. ...	132—134	–3	134—135½
245,800	,,	June 22	5	5	Do. 5 p.c. Red. Pref ...	103—108	...	...
306,083	,,	July 6	4	4	Do. 4 p.c. Deb. ...	104—106	...	...
106,280	,,	July 20	10	10	Preston 'A' 10 p.c. ...	198—208	...	...
189,219	,,	,,	7	7	Do. 'B' 7 p.c.	137—147	...	...
NEWCASTLE EXCHANGE.								
122,877	Stk.	Aug. 10	8	8	Blyth 5 p.c. Ord.	153—155	...	...
732,000	,,	Aug. 10	5	5	Hartlepool G. & W. Co. & New	125—127	...	...
2,061,315	,,	Aug. 10	5½		Newcastle & Gateshead Con.	28 —28/6a	...	...
692,856	,,	,,	4	4	Do. 4 p.c. Pref. ...	104—106	...	...
776,704	,,	June 22	3½	3½	Do. 3½ p.c. Deb. ...	100—102	...	...
277,285	,,	May 4	5	5	Do. 5 p.c. Deb. '43...	108—109	...	...
209,820	,,	Aug. 10	8½	8½	South Shields Con.	172—174	...	...
299,542	,,	Aug. 10	6	6	Sunderland 6 p.c. max. ...	132—134	...	...
NOTTINGHAM EXCHANGE.								
542,270	Stk.	Aug. 10	10	7	Derby Con.	185—195	...	...
55,000	,,	June 22	4	4	Do. 4 p.c. Deb.	100—105	...	...
84,750	,,	Feb. 17	5	12	Long Eaton 'A' Ord. ...	...	...	...
50,000	,,	,,	4	10	Do. 'B' Ord. ...	...	...	...
20,000	10	June 8	5	5	Do. 5 p.c. Pref. ...	10—12	...	...
60,000	Stk.	,,	5	5	Do. 5 p.c. Deb. ...	117—122	...	...
SHEFFIELD EXCHANGE.								
10,000	Stk.	Aug. 10	10	10	Great Grimsby 'A' Ord. ...	220—230	...	...
6,500	,,	,,	10	10	Do. 'B' Ord. ...	220—230	...	...
79,008	,,	,,	10	10	Do. 'C' Ord. ...	205—215	...	...
1,806,339	,,	Aug. 24	6	6	Sheffield Cons.	146—148	...	...
95,000	,,	July 6	4	4	Do. 4 p.c. Deb.	102—105	...	...

a The quotation is per £1 of Stock.

Supplementary List of Stocks and Shares not Officially Quoted

202,152	Stk.	Nov. 2	5	25/–*a*	Ascot Ord.	118—123	...	...
128,182	,,	July 6	...	5	Do. 5 p.c. Pref.	115—120	...	...
238,631	1	Nov. 16	5	5	Assd. Gas and Water Ord....	20/6—22/6	...	...
323,681	1	,,	4½	4½	Do. 4½ p.c. Cum. Pref. ...	21/—23/-	...	...
150,000	Stk.	Sept. 21	...	3½	Do. 3½ p.c. Red. Deb. ...	98—101	...	...
17,000	,,	Aug. 24	8	8	Bognor Orig. Ord. 'A' ...	175—185	...	...
62,210	,,	,,	8	8	Do. New Addl. 'A' ...	175—185	...	...
87,169	,,	,,	7	7	Do. New 7 p.c. max. ...	145—150	...	...
37,440	,,	Aug. 10	10	10	Cam.Univ. & Town 10 p.c.max.	205—215	...	...
125,970	,,	,,	7	7	Do. 7 p.c. max.	155—160	...	...
39,025	,,	,,	5	5	Do. 5 p.c. max.	108—113	...	...
65,000	,,	Aug. 10	8½	7½	Eastbourne 'A' 5 p.c. ...	175—180	...	...
198,000	,,	,,	7	6	Do. 'B' 3½ p.c.	142—147	...	...
112,312	,,	,,	5	5	Do. 5 p.c. Pref.	118—123	...	...
130,000	,,	June 22	5	5	Do. 5 p.c. Deb.	124—129	...	...
24,000	30	Aug. 10	8½	8½	Great Yarmouth 8½ p.c. max.	51—56	...	...
39,400	30	,,	7½	7½	Do. 7½ p.c. max.... ...	42—45	...	...
51,160	Stk.	June 8	5½	5½	Do. 5½ p.c. Deb.... ...	123—128	...	...
182,600	,,	Sept. 7	8	8	Guildford Cons.	182—192	...	...
54,055	,,	,,	5	5	Do. 5 p.c. Pref.	114—119	...	...
68,250	,,	June 8	5	5	Do. 5 p.c. Deb.	120—125	...	...
156,600	,,	Aug. 24	7½	7½	Hampton Court Cons. ...	173—178	...	...
107,960	10	Oct. 5	5½	4	Mid Kent Ord.	10—11	...	...
230,940	Stk.	Aug. 10	10	10	Oxford & District Ord. ...	215—225	4 5	217—218
47,112	,,	,,	5	5	Do. 5 p.c. Pref.	118—123	...	...
50,000	,,	,,	6	6	Do. 6 p.c. Red. Pre ...	113—118	...	...
126,193	,,	Nov. 16	7½	7½	Peterborough Ord.	162—172	...	...
64,990	,,	Sept. 7	6½	7½	Redditch Ord.	133—143	...	...
166,850	,,	Aug. 10	9	8	Romford Ord.	168—178	...	175...176
60,000	,,	,,	4	4	Do. 4 p.c. Pref.	97—100	...	...
44,000	,,	Sept. 21	5	5	Do. 5 p.c. Deb.	120—125	...	...
10,950	,,	Aug. 24	8	8	Ryde Ord.	165—170	...	...
136,191	,,	Aug. 10	7	5	Scarborough Ord.	126—136	...	...
27,825	,,	Aug. 24	8	8	Shanklin & Ventnor Cons. ...	180—190	...	...
40,643	,,	Sept. 21	7	7	Slough Ord.	156—161	...	...
221,000	,,	June 22	5	5	Do. 5 p.c. Deb.	116—121	...	...
28,872	1	Nov. 2	5½	5½	S. Midland Gas Cpn. Ltd. Ord.	22/—24/-	...	...
28,866	1	Sept. 7	4½	4½	Do. 4½ p.c. Red. Cum. Pref.	22/—24/-	...	...
137,730	Stk.	Aug. 10	7	7	Southgate & Dist. 7 p.c. max.	151—156	...	...
62,500	,,	,,	5	5	Do. 5 p.c. Pref.	120—125	...	...
117,228	,,	Aug. 10	6	5	Swindon Cons.	110—115	...	...
60,425	,,	June 22	5	5	Do. 5 p.c. Deb.	120—125	...	...
64,380	,,	June 8	5	5	Torquay and Paignton 5 p.c. Pf.	117—122	...	...
750,000	1	Oct. 5	5·52d.*a*	4	Utd. Kingdom Gas Cpn. Ord.	21/6—22/6	...	21/10½—22/6
468,574	1	,,	2½	2½	Do. 4½ p.c. Prefd. Ord....	20/—22/-	...	21/6
935,902	1	Nov. 16	4½	4½	Do. 4½ p.c. Cum. Pref.	22/6—23/6	...	22/10½
600,000	Stk.	Sept. 21	3½	3½	Do. 3½ p.c. Red. Deb. ...	99—102	...	101
130,000	,,	Aug. 10	8	5	Wakefield Ord.	140—145	...	147
81,650	,,	,,	5	5	Do. 5 p.c. max.	105—110	...	...
82,000	,,	July 20	6	6	Weymouth Ord.	105—110	...	...
98,384	,,	Aug. 10	6	6	Wolverhampton 6 p.c. Pref.	127—132	...	...
160,000	,,	June 8	5½	5½	Do. 5½ p.c. Rd. Db	107—112	...	...
370,000	,,	July 20	6	4	York Cons.	118—123	...	...
90,000	,,	June 22	5	5	Do. 5 p.c. Red. Deb. ...	110—115	...	...
133,640	,,	July 20	6½	6½	Yorkstown (Cam.) 5 p.c. Cons.	150—160	...	...
120,000	,,	,,	5	5	Do. 5 p.c. Pref.	123—128	...	...
35,000	,,	June 22	5½	5½	Do. 5½ p.c. Deb.... ...	130—135	...	...

a Actual.

"Modern Gas Fitting"

PART VI.

of

Gas Fitting Pamphlets

Another of the Popular Series of reprints, in booklet form, of the articles on "Modern Gas Fitting," contributed monthly to the

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Officer-in-Charge of Training, The Gas Light and Coke Company, Assistant Head of Department of Gas Engineering and Supply, Westminster Technical Institute.

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